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SURGICAL EXPERIENCES IN THE PRESENT WAR[1]

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I. GUNSHOT WOUNDS AND THEIR TREATMENT[2]

SURGEONS who were responsible in the early weeks of the present war for the treatment of the wounded soldiers coming home from France are, I think, never likely to forget their experience. There were wounds of many dimensions and of every tissue, all characterized by the most profuse and offensive suppuration. No one in active work had ever met with cases like all of these. Whether a surgeon had practiced "aseptic" or "antiseptic" surgery, he had been able to secure with gratifying constancy a blameless healing of the wounds he had made, he had rarely seen a profoundly septic wound, and the methods he had at his disposal for dealing with them were almost always easily capable of reducing and controlling the infection. Suddenly he was confronted with a long succession of cases in which a raging and often a rancid suppuration was present, and he found that all the old remedies, upon which he had so comfortably and so confidently relied, were hopelessly inadequate and futile. A challenge was, so to say, thrown to the profession, and I think we may now with due modesty claim that it has been splendidly and triumphantly met. Rebukes and taunts at our incompetence were not seldom heard in those far off days. We were asked if Lister had worked in vain; we were told we had failed to learn the lesson he had spent his life in teaching.

It is interesting to read again the works of Lister, and to see how helpless he felt himself in dealing with putrefactive processes once firmly established in a wound. Lister everywhere distinguishes between the "prophylactic" and the "therapeutic" uses of antiseptics. All the marvelous achievements of modern surgery are due to the adoption by surgeons the whole world over, of the principle of the prevention of infection in wounds about to be made as distinguished from that of the subduing of an infection already rampant.

Lister writes: "The orginal idea of the antiseptic system was the exclusion of all

[1] The opinions expressed in the following papers are based, not only on my own experience overseas and in England, but upon the work I have seen in a large number of hospitals, both in the French Army and in our own, and upon the many discussions I have had in many places and on many occasions, with my colleagues. I desire especially to thank, in the French Army, Professors Tuffier, Gosset, and Pierre Duval. I may most appropriately quote: "I have gathered a posie of other men's flowers, and nothing but the thread that binds them is mine own."

[2] Read before the Clinical Congress of Surgeons of North America, Chicago, October 22-26, 1917.

microbes from wounds." Again, "During the operation, to avoid the introduction into the wound of material capable of inducing septic changes in it, and secondly to dress the wound in such manner as to prevent the subsequent entrance of septic mischief." Again, "In wounds already septic attempts are made with more or less success to restore the aseptic state." Again, "In speaking of the antiseptic system of treatment, I refer to the systematic employment of some antiseptic substance so as entirely to prevent the occurrence of putrefaction in the part concerned, as distinguished from the mere use of such an agent as a dressing."

The distinction between the preventive and the curative use of antiseptics is in many respects that existing on the one hand between the power of a germicide as determined by experiments *in vitro*, and on the other hand, its capacity to destroy organisms when it is introduced among the living and the dead tissues of a wound. In the former there is a direct conflict, a clean fight, between the microbe and the chemical agent. Few or none of the many intervening conditions are present which have to be considered when a bactericide is introduced into a wound cavity wherein there are a multitude of actions and reactions which even now seem very obscure and are so often conflicting.

When after the lapse of many weeks from the outbreak of war, there came a full appreciation of the several circumstances which had to be reckoned with when a solider was wounded, it was recognized on all hands that a new and grave problem had arisen which cried urgently for solution. What then were the several new factors that had to be considered?

In the early days a very large number of the wounds were inflicted by rifle fire. The German bullet has a muzzle velocity of approximately 1000 yards per second. In the first 800 yards or thereabouts, the flight of the bullet is not steady but "wobbling." There are three movements: a movement forward along the line of flight; a rotary movement, in which the bullet spins round on its longitudinal axis as a result of the "rifling" of the barrel; and a third movement, a *mouvement de bascule* of such a character that while the point of the bullet keeps steady the base of the bullet is moving round a circle, or an ellipse, of a gradually diminishing size. The result of the last form of motion is this, that when the bullet impinges upon any substance, even the soft clothing or the flesh, the infinitely brief arrest of the point which strikes first, allows the base, which is of course much heavier, to overtake the apex, and the bullet then lies sidewise or begins to turn over and over as it ploughs its way through the soft parts. In this early part of the trajectory the missile has, of course, a great momentum; it is a heavy bullet traveling with great velocity. The consequence is that the damage inflicted is not confined to the track it rudely makes through the limb: the parts around the track are damaged also, often to a great extent, and microbes are driven deeply into all adjacent tissues. Every wound, therefore, caused by a bullet at short range, consists not only in a visible tearing and destruction along the path the bullet has followed, but in a dead zone everywhere surrounding that track — a zone in which death or destruction or disintegration of the parts has occurred by reason of the tremendous concussion produced by the bullet as it tore its way clumsily through the tissues. Sir Anthony Bowlby has illustrated this by a series of exemplary instances. In one of these, the kidney was wounded in its lower pole; the upper pole appeared normal to the naked eye, yet on microscopic examination the tubules were seen to be disorganized. Other examples of the widespread damage inflicted are quoted in his Bradshaw lecture. And even that is not all. The momentum of the bullet is such that to everything it encounters it imparts some of its own velocity. As we all know, shreds of the clothing or belt, or the contents of the pocket, may be carried deeply into a wound. So also are pieces of skin or muscle. And if the bullet should chance to strike a bone, the bone is not only broken into many fragments, the "splinter" fracture, but to all fragments there is conveyed enough of the momentum of the bullet to convert them into projectiles also, capable of tearing a way into the softer tissues. Many of the wounds, therefore,

were deep, irregular in shape, with large or small cavities; of the variety the French term "anfractuous." Into these recesses blood escapes, and owing to the tearing and unequal retraction of cut muscles, pools of fluid may be shut off from the main track of the wound, and form an ideal breeding ground for all micro-organisms, especially those which are anaerobic.

If a rifle bullet is not checked in the first 600 yards of its flight, it begins to steady down, and probably when it has traveled 1000 yards it is moving evenly. An injury inflicted then is of a quite different character. The bullet cleaves it way through the soft parts, bores a neat hole through a bone, and little destruction is done. We see many cases where the chest or abdomen are traversed from side to side, or where the neck has been pierced, and miraculously, no real damage has been done. Examples of this form of injury were, of course, common enough in the South African War. They have been less frequent in this war because the range has often been shorter, and the bullet in respect to velocity and weight is different.

During the last two years a very large proportion of the wounds have been inflicted by shrapnel bullets, hand grenades, or shell casing. The immense velocity of the projectiles, especially when a high explosive shell bursts, their irregular shape, their pitted surface and sharp edges, all combine to cause wounds of very diverse forms. The track is a distorted one, the parts around it are bruised and battered or dead, and the infection carried into the wound by a piece of metal or cloth has unrestricted opportunities of spreading rapidly. In many cases large areas of the limbs or trunk are blown away. The wound remaining shows a shattered and irregular surface; the muscles are torn and crushed, or "pulped" and lose their structure. They dry rapidly on exposure and therefore fall easy victims to a bacterial attack often of great ferocity.

The condition of the battlefields of Flanders and of France accounts for the quality of the infective agents. Many parts of the lands over which the fighting has taken place, both before and since trench warfare set in, were cultivated assiduously by the rural inhabitants before the war. Probably no soil in Europe has been more liberally manured in efforts at intensive cultivation. Certainly no contact between the soldier and the soil has ever been more intimate or more protracted. In the winter the whole fighting zone is, in Sir Douglas Haig's phrase, a "wilderness of mud." In the summer it rivals the desert in a sand storm; dust is everywhere. It steals into the eyes and nose and throat and ears, it grimes the face and hands, it fills the hair, it penetrates every vestment. Every projectile passing through the garments to the body will certainly be covered with the mud or dust in the clothes, and with the many organisms that a respite from ablutions has allowed to penetrate the skin. All bacteriologists and surgeons are now agreed that no influence perpetuating infection in a wound is so malign as that which is harbored in the torn fragments of clothing. The physical condition of the soldier himself, when he is wounded, no doubt plays an important part in exalting the virulence of any infection which may settle upon him. Though in the best of health and physical condition at the moment of attack he may, by the time he is wounded, have suffered great fatigue, and bleak exposure, for hours, or even days, before succor comes to him. The organization for the collection and despatch to the field ambulances and casualty clearing stations, of wounded men is probably as perfect as any endeavor can make it. But there are times, expecially in a "push" when a man may lie out undiscovered for long periods. Not infrequently by reason of such causes, and on account of pain and hunger and loss of blood, he may be reduced to a state in which his power of resistance to a bacterial attack is greatly impoverished.

Bacteriology. The bacteria infesting the wounds in France have been studied by Wright, Fleming, and others. The general conclusion drawn from their work is that the micro-organisms, as might be expected, are those found in highly manured soil; they are, that is to say, of fæcal origin. Wright suggests, with his customary fecundity of invention, the new names "serophytes"

for those organisms which will grow in normal serum, streptococci and staphylococci; and "serosaprophytes" for those which can only grow in digested albumens. The native albumens of human serum are "protected" from bacterial development at their expense, and Wright points out that, if this were not so, human life would have been impossible. Among the serosaprophytes are the larger number of the organisms found in wounds, including all the anaerobes; the bacillus of Welch, the bacillus of tetanus, the enterococcus, a streptococcus of intestinal origin described by the French, the bacillus coli, and putrefactive bacilli X and Y, which are the cause of the foul odor often met with in wounds. There is often a "wisp" bacillus and a diphtheroid bacillus appears in later stages of the infection.

All these micro-organisms find a most fertile medium for their growth in wounds of the character I have described. In every anfractuous wound, where the recesses are many and intricate, blood or serum may be poured out; tryptic digestion begins as a consequence of the destruction of the leucocytes, peptones are formed and bacteria, finding everything to their liking, grow apace. From many of the wound surfaces the circulation has been cut off by the powerful stunning effect of the blow given by the projectile, and gangrene and sloughing make haste to develop. During the first 4 to 6, or in some cases even 8 hours, few organisms, or none, can be recovered from the wounds, either by smear methods or by cultural methods. The organisms are there nevertheless, and given the prodigal fertility of the soil in which they are sown, will quickly show the evidence of their growth. In this brief early period the wound is said to be "contaminated," in all later periods "infected."

Against this attack made upon it by immeasurable millions of organisms, how does the body protect itself? The chief defense is in the blood serum and in the leucocytes (phagocytes). The capacity of these two, if only they have an adequate chance, may be said to be almost illimitable against all organisms but the streptoccocus. The serum possesses strong bactericidal powers of its own; the phagocytes can devour bacteria greedily. But in exerting their powers, both serum and white cells are apt to undergo degradation. The leucocyte breaks down and its power of tryptic digestion is then exerted upon the fluids around it, and peptones are produced in quantities which make easy the growth in them of all forms of bacteria. Moreover, the surface of the wound soon becomes "lymph-bound." A mesh of fibrin entangles the blood-cells, and a sort of matting of coagulated lymph spreads over all the surface. No fresh serum can then reach the wound, nor are fresh leucocytes available for the attack. The infective process can then proceed apace, unhindered by those powerful natural defenses which for the moment have quite broken down.

THE PRINCIPLES AND METHODS OF TREATMENT OF GUNSHOT WOUNDS

a. Primary closure. Everyone to whose lot it has fallen to undertake the surgical treatment of wounds in this war will agree that the most urgent need is to secure their complete closure at the earliest possible moment. In the early hours, during the period of "contamination," it is now the common practice to excise freely all damaged and dead tissue if possible in one piece. This requires some skill and no little practice to do excellently. The most careful preparation of the skin and the parts around the wound is a necessary antecedent to any operative measures. The wound, of whatever type, is excised together with a wall not less than one-third inch around it. In order to make certain that all the walls of the original wound are excised, Wilson Hey has suggested, and has long employed, a method of staining with brilliant green, which is injected into all parts of the wound and allowed to remain not less than two minutes. The staining of a wound not only makes a more thorough removal possible, but it also indicates those parts which can not, or may not, be removed, to which therefore a simple mechanical cleansing must be more particularly directed. When staining has been thought unnecessary, he tells us the final results are worse. Staining in every case is a help; it is never a

hindrance. The walls of the cavity remaining after excision should bleed everywhere: perfect hæmostasis is then secured. Every soiled instrument or glove is at once discarded. The wound may then be stitched up completely without drainage, and with much confidence may be expected to heal well. The cases coming to the base hospitals in England show that in a great variety of injuries this method of the primary closure of wounds is meeting with a very remarkable success. If the operation is carried out with scrupulous exactitude and with something near to technical perfection in cases of "contaminated" wounds, probably not less than 90 per cent will heal by first intention. The failure occurs in those cases where a piecemeal removal of the infected wall has been carried out, where, that is to say, there has been frequent re-infection of the newly made raw surfaces.

There has been in all armies a certain timidity, very natural, and perhaps from many points of view very desirable, in carrying out the method of primary closure. No one who has worked even for a brief period in the armies in France can have failed to realize the desperately serious results which come from the injudicious closure of septic wounds. Gas gangrene, for example, may develop in an amputated stump, if even one stitch is put in to approximate the flaps. And there has consequently sprung up on all sides a fear of the premature closure of wounds. But recent experience would seem to show that at least in the early cases, in cases reaching a well-equipped surgical unit, say within 8 or 10 hours, in the period of contamination rather than of spreading infection, a mechanical cleansing of the most thoroughgoing kind, carried out ruthlessly and rapidly, will allow the great majority of the cases to be closed with an excellent chance of primary union. There can no longer be any doubt that many of the cases which have proved so successful under the Carrel-Dakin method, applied during the first 6 to 8 hours, would have closed equally safely, and far more rapidly, under the method of immediate suture; and that consequently a certain degree of suffering and much expenditure of time and no little expense would have been saved. To put this statement in what may seem an extreme fashion, it may be said that the Carrel-Dakin method has achieved its greatest triumphs in cases where it need not in fact have been applied. But if this opinion is true it must at once be admitted that one of the chief experiences which have led to its realization is the practice of this method, with great success during many months. More than ever are we now confirmed in our strong opinion that it is the primary mechanical cleansing, after thorough exposure, and with every precaution and care, that is the supreme necessity in all cases; and that this alone, if complete, will allow the natural defenses of the body to secure the blameless healing of the wound. In doubtful cases, indeed in any case, a small drain of a few strands of silkworm-gut may be left in the corner of a wound closed by primary suture. All cases are watched carefully for a few days. If the temperature remains high, or if the wound on being uncovered looks angry, inflamed, and especially if a streptococcus infection is found, the wound must be opened up completely and treated by one of the methods to be presently described.

b. Secondary closure. If, however, owing to one or more among a great diversity of circumstances, the patient arrives at a base hospital with a freely suppurating wound, the problem is quite different. The chance of primary closure has passed away perhaps long ago; the wound now may be covered, sparsely or thickly, with sloughs of varying size, and in various stages of detachment. Layers of lymph adhere to one point, or at many, to the wound surface, and the discharges are thick, purulent, and offensive. The problem here is first to secure a healthy and relatively uninfected surface, and secondly to close the wound by suture on the earliest prudent occasion. What are the principles which we must now put into practice? For purposes of tabulation and description, they may be spoken of as "physiological" and "antiseptic," though, as I shall indicate, the difference between the two may not be so sharp as such a precise and limited statement might appear to indicate.

Physiological methods. These owe their origin to Sir Almroth Wright. The problem Wright set himself to solve, in the case of the septic "lymph bound" wound, was that of rendering available, once more, all the natural defensive mechanisms possessed by the body fluids and tissues, and of exalting their power by bringing them into play in far larger quantities than are usually at our command, and in a condition which, as a result of vaccine injections, or because of the increased antitryptic power of the blood serum of a wounded man, finds them greatly augmented. We have, he says, to promote the destruction of the microbes which have been carried into the deeper tissues; we have to resolve the infiltration in the walls of the wound, and to get rid of infected sloughs; we have to prevent the "corruption of the discharges," and to inhibit microbic growth in the wound; we have to be constantly on our guard in order to prevent those active and passive movements which propel bacteria along the lymphatics, and which carry poisonous bacterial products into the blood; and finally, all this being done, we have to get rid of the surface infection, promote the processes of repair in the wound, and bring together the wound surfaces so that they may heal.

How are these various tasks successfully accomplished? The blood serum, as Wright has shown, possesses certain remarkable properties. Mechanically it is the agent by which phagocytes are washed on a rising tide into the wound, and chemically it has a powerful bactericidal efficiency against all micro-organisms, but the "serophytes," streptococci, and staphylococci (the anaerobic organisms that is to say) are destroyed by it. The phagocytes as Metchnikoff long ago showed us can devour and digest micro-organisms of all kinds, but, tried beyond a certain point, they perish in the fight, and liberate at their death a ferment, trypsin, which digests the native albumens in the serum, converts them into peptone, and therefore adds enormously to the cultural value of the wound discharges. The blood, however, is normally antitryptic, and this quality appears in cases of infection to be increased—there is an antidote, that is to say, to the local defeat of the phagocytes and the consequences attaching thereto. The coagulability of the serum is also increased with the result that a "felting" of fibrin forms on the walls of the wounds, and prevents the access to the wound of reinforcements of serum and of cells. Wright's method consists in the application of a "hypertonic" solution of salt, 5 per cent or anything over that, together with ½ per cent citrate of soda (this is not necessary). The principle of the hypertonic method is to make use of the bactericidal power of fresh serum which is encouraged to flow from the wound surfaces by the application to them of a more concentrated saline solution than blood serum. A process of osmosis is at work. It is argued, or rather asserted, which is not the same thing, that serum is a fluid which will not osmose, but the fact is indisputable that when these strongly saline dressings are applied, the discharge from all the wound surfaces is increased enormously in quantity. The patient is often compelled to drink freely, so considerable may the drain of the fluid be. The discharge from the wound after the first few hours becomes clear and within 3 or 4 days may be found sterile or of low bacterial content. The streptococcus is by far the most resistant of all micro-organisms; after 3 to 5 or 6 days it is often the only germ remaining. As I go round from one hospital to another, or from one ward to another, I think I am generally able to pick out the cases which are being dressed by Wright's solution. The granulation tissues have a fuller, deeper color, and the surface looks cleaner than when any other form of dressing is being used. The blood serum has now done its work. During this time the phagocytes have been inhibited in their action and even destroyed, as I shall presently mention. It is their aid which is, however, supremely necessary in the attack upon the serophytes. The hypertonic solution is, therefore, changed for an isotonic solution which encourages the migration of leucocytes and leaves them to deal with the streptococci and staphylococci (generally few in number) that alone remain in the wound. When bacteriological examinations reveal that the wound is "clinically sterile," it may be sutured, or its edges approximated by strapping.

The action of hypertonic saline solutions is complex, and its virtues conflicting. It attracts water from the blood together with all the protein substances contained therein; it inhibits leucocytic migration, prevents phagocytosis, disintegrates those leucocytes with which it is brought into direct contact and thus sets free a tryptic ferment which digests the albumens of the blood serum. It delays or prevents the action of this very ferment which it has caused to be liberated. It inhibits coagulation and so prevents the sealing up of the channels through which lymph pours into the wound. It appears definitely to inhibit bacterial activity and propagation.

Various modifications of Wright's original procedures have been made. Before I left France for the first time, in March, 1915, we had begun to use salt tablets, wrapped in gauze, in the wound, at the suggestion of Colonel Lawson, with the intention of keeping available in the wound cavity a constant supply of a hypertonic solution. This method was afterward widely used and warmly advocated by Colonel Gray and Major Hull, who designed the "salt pack," a most useful and valuable form of dressing. After appropriate cleansing a wound may be filled with a number of salt packs, protected by a few layers of gauze from actual contact with the granulating surfaces so as to avoid sloughing, and left for 8 or 10 days. The dressing becomes very offensive; but on its removal a bright, even, and healthy layer of granulations covers every part of the wound. This method is of great value in many cases of secondary hæmorrhage where only smaller vessels are involved; and is of the greatest service in those cases where transference of the patient from one hospital to another is necessary. Colonel Sargent has recently used an ointment made of vaseline with 5 per cent salt added thereto; after a thorough cleansing and a sparing application of this preparation a secondary closure of the wound will be followed by healing. The various papers of Sir Almroth Wright on "physiological methods" and on the treatment of wounds have helped us to realize better than ever before the immense complexity of the problems concerned with the healing of septic wounds and clearly to understand the principles upon which we must rely in order to promote union.

Antiseptic methods. Before any discussion with regard to antiseptic methods can be productive of good we must ask ourselves the question, "What is it we expect an antiseptic to do in an infected wound?" The answer most commonly given by those to whom I put this question is that an antiseptic acts by destroying bacterial life. But a great many qualifications must be given before such a reply can receive even a slender acquiescence. The problem of the action of an antiseptic in an infected wound is far too complex for a simple and ready answer. We know in truth very little even now of what goes on in all parts of a septic wound. But we may be quite certain that an antiseptic is never "monotropic," engaging one substance only. It may have an affinity for the tissues forming the wall of the wound, for the serum or for the leucocytes, or for the gauze packed into the cavity of the wound, or with the dressings applied to the surface. It may have opposing effect on different parts of the wound; it may, for example, increase proteolytic digestion in its action upon sloughs, and it may inhibit or prevent this process by its effect upon leucocytes and their emigration. An antiseptic, however potent *in vitro*, may be quenched by the other substances I have named and fail to influence the bacteria in any direct way. Moreover, the bactericidal power of an antiseptic is no criterion of its penetrative power. Its bactericidal power is at once profoundly modified by its contact with albumen, with which it most eagerly combines, as is also its power of diffusion, and therefore of reaching in a still active condition all the crannies and chinks among the recesses of the wound. The direct germicidal effect of any antiseptic is, therefore, almost certainly very much smaller than many of us had supposed, and is confined chiefly or exclusively to those bacteria which are lying bare to its attack in the open wound. I have, moreover, always thought it very difficult to credit the supposition that an antiseptic, however applied, can have an efficient action

against micro-organisms in a wound without producing also a very harmful effect upon the body tissues and fluids. Or in other words exclusive reliance upon an antiseptic to act as a germicide is a negation of all dependence upon the principles of physiological reaction of the tissues to a bacterial attack. These points will emerge more clearly in connection with a brief description of the various methods of "antiseptic treatment" adopted at the present time in the zones of the war.

Among these, pride of place will cheerfully and gratefully be conceded to the Carrel-Dakin procedure. It consists, as all surgeons now know, of a free mechanical exposure and cleansing of the whole wound. This is so easy to say, and alas, so difficult in all cases to carry out adequately. The wound so made is then lightly packed with gauze into which a number of Carrel's tubes are laid; through these tubes at intervals of about two hours Dakin's fluid is instilled. Probably full realization of the need for careful preparation and testing of Dakin's fluid is not universal; nor of the rapid deterioration in its potency if it is allowed to be heated, or exposed to the air, or stored in transparent glass bottles in warm places. The method allows of the early secondary closure of wounds, at an average period of 8 to 12 days; and coming when it did before the end of the first year of the war, it is no exaggeration to describe its effects upon the treatment of wounds as revolutionary.

In what way does the Carrel-Dakin method act? Are its effects produced by reason of the strongly antiseptic properties of Dakin's fluid, or because of other properties not directly concerned with the killing of micro-organisms? Or is the most excellent technique for which we cannot be too grateful to Carrel chiefly responsible in that it necessitates a greater general care of the wound, a free opening of all recesses, and that constant supervision which detects at the earliest moment any harmful development on the granulating surface? If strict dependence is placed upon the microbial curve, it would appear that the author of the method believes that progressive sterilization of the wound is produced by the chemical action of Dakin's fluid upon the bacterial flora. The reduction in the number of organisms even irrespective of their nature, is held to be the index of the germicidal effect of the fluid applied. Even when comparatively small quantities of a potent bactericidal fluid, like that discovered by Dakin, are instilled frequently into wound cavities covered by sloughs or granulations, the killing of microbes can hardly be of serious consequence. For these organisms can propagate themselves at a rate with which the most powerful germicide could hardly "catch up," however frequently or adequately supplied. I can easily conceive of an "antiseptic," using the word in its clinical sense, which is not in the smallest degree "germicidal." I can understand, that is to say, that a wound, however gravely infected, may by the application of some chemical substance be deprived of its bacterial flora, in very great measure, or even completely, though no single micro-organism is killed by this substance. An "antiseptic," if not germicidal (that is, not acting chemically upon the substance of which bacteria are composed), might yet render the wound sterile either by destroying the pabulum of the bacteria, so that they are unable to flourish and to propagate, or by exalting those normal powers of resistance possessed by body tissues and fluids, or by holding up the bacteria until those powers, without increase, are capable of destroying or dispelling the infective agents. Or does the action of chemical agents on the leucocytes so alter their metabolism as to produce substances which cause degenerative processes in the bacteria? That is, are involution forms of bacteria developed by the relationship of these agents to them? The most striking effect visible to the eye in a wound treated by the Carrel-Dakin method is that the surfaces are cleaned very rapidly. Dead tissue, even large sloughs, are quickly digested away, and the surface becomes smooth, clean and bright red in color. In a wound not yet clean in all its parts a very different microbial curve can be drawn if smears are taken from the smooth red portion of the surface and from the edge of a slough. It is the dead tissue in the wound that keeps the septic processes going. If this is destroyed, bacte-

rial profusion and virulence both rapidly diminish until the wound is "clinically sterile." If, therefore, a substance could be found which without having a directly noxious effect upon bacteria could rid the wound of all dead tissue and allow the natural defensive mechanism to have a free chance, it is probable that the wounds would heal as kindly as they do under the Carrel-Dakin system.

What appears to be a fulfillment of this supposition has been published since the above paragraph was written. Donaldson and Joyce[1] describe a non-pathogenic spore-bearing anaerobe, which acts apparently in virtue of its proteolytic powers only on devitalized tissues, and possibly on tox-albumens, and appears to possess no power of attacking healthy tissues. The powers of this organism are directed toward the removal not only of the grossly damaged tissues, but it succeeds also in attacking the microscopically damaged structures. As a result, the body forces are freed from the constant menace of septic poisoning and are thus allowed to commence the work of repair. It is, therefore, an arguable proposition that Dakin's fluid as applied by the Carrel technique does not act as a germicide but rather as a proteolytic agent, as an agent destroying those parts of the wound on which alone, or chiefly, organisms can find a place to propagate. It is, after all, therefore the mechanical cleaning of the wound which is of the greatest importance, and the action of Dakin's fluid is perhaps very much the same as that of the surgeon's knife in those cases where the wound is excised.

The Carrel-Dakin method always stops short of perfection in asepsis. The wound in my experience is never rendered "sterile" by this method. Organisms can be found in smears and developed in culture, however long the treatment is continued in a large wound, a fact which seems to me of great significance in relation to the question of the bactericidal value of Dakin's fluid. For when fluid in the same quantity as ever is applied, and but few micro-organisms remain, their ultimate annihilation appears to be impossible. Perfect sterility, however, we have long known is not necessary for a healing by first intention; though the quality of that healing varies decidedly according to the relative infectivity of the wound. The fewer and less harmful the organisms the more blameless is the healing. Surgeons who have worked, as surgeons should work, with a bacteriologist at their elbows, will admit they have frequently closed wounds which were proved to contain micro-organisms, and yet have obtained a union of the wound that was good. Until I adopted my present technique, this was a frequent experience; but many years ago I began (I was, I believe, the first to begin) the covering of the skin by tetra cloths which overlapped the skin edges, and since then I can be certain that in all clean cases the wound remains sterile to the end of the operation and a flawless healing can be confidently expected. Carrel has coined the phrase "clinical sterilization" to indicate that condition in which organisms are so few that the wound can safely be closed and good healing obtained. Regard should, however, be paid not only to the number of the microbes but to their nature. I do not like to find a streptococcus present when the day approaches for the secondary suture of a wound. Carrel's method must rely at the last upon the living properties of the tissues to destroy or render innocuous the organisms still remaining in the wound when it is closed. It is true that they are few: but they are there nevertheless, and must be overcome if the wound is to heal, and to remain healed. What most surgeons have learned since the introduction of th's technique is that which those surgeons who worked with a bacteriologist by their side have long known: namely, that infected wounds (wounds "clinically sterile") may heal in a manner to which the term "first intention" may without injustice be applied.

What are the disadvantages of the Carrel-Dakin method? I often hear it said that it is a difficult method, requiring a special training of the surgeon, that it requires a large amount of glass and rubber tubing, bottles, etc., that it is costly in dressings, and that it calls for constant supervision or direction by the surgeon. There is truthfully no great validity

[1] Lancet, Lond., 1917, ii, 445.

in these objections. A special instruction of the surgeon is certainly necessary if he is to observe the ritual carefully, and to understand what it means; but so it may be said is a special training necessary for the surgeon when any new technical procedure is introduced. The apparatus is cheap, and is easily obtained and lasts with care for months. If nurses are carefully trained to do the dressings with punctilious care, only that supervision is needed from the surgeon which he should give to every case. From a military point of view, however, it is a difficult method of practice, for in our army we are compelled to evacuate a large proportion of cases to England, retaining only those for whom movement has proved disastrous. The circumstances under which Carrel worked and under which he produced his splendid results could not conceivably be made applicable to a whole army. Some part of his success must truthfully be given to his opportunities both for receiving the cases early and retaining them for long periods.

The chief disadvantage of the method is that if it is interrupted it fails lamentably. When cases have to be transferred from France to England, it may for certain reasons be impossible to survey all the cases on board ship or on the train; and infection then spreads and a rancid and rampant suppuration is present when the patient arrives at a base hospital in England. This is, it is true, an objection to a particular application of the method, rather than to the method itself. But it is the reason, I think, that the procedure has never found a wide or general acceptance in the British Army, though it has many warm advocates, and many who practice it with a success equal even to that of Carrel or of Chutro. The chief successes obtained by this method are in the early cases, in those in which treatment can begin at intervals of not more than six or seven hours after the wound is made. But we are by degrees becoming less timorous in our efforts at primary closure in precisely this group, and our results justify a wider acceptance and a more general adoption of this practice. In later cases the Carrel method is beyond question a therapeutic procedure of the first magnitude, but it then requires, unwearying care and inexhaustible patience if the best results are obtained.

Rutherford Morison's method. This method is widely practiced in the base hospitals in England, and by many surgeons is considered the most satisfactory of all. The technique is as follows: a wound, say of the arm, leading down to a compound comminuted fracture of the humerus is freely opened up, after such preparation of the arm and of the surrounding parts as is made in all cases about to undergo operation. The skin, that is to say, is prepared with soap, antiseptic washes (Morison uses $1/20$ carbolic acid lotion) and spirit. The wound may be enlarged in any direction in order to make sure that no recesses in it remain undiscovered. All granulation tissue is vigorously scraped away from the wound surfaces; bleeding points are secured; obviously dead and loose portions of bone, or pieces of cloth, or projectiles are removed. The wound is packed with dry gauze for a minute or two, while towels about the wound are changed if necessary, and while the surgeon replaces all instruments, gloves, etc., with those freshly sterilized. The dry gauze is removed, the wound sponged everywhere with gauze moistened with methylated spirit. On to the raw wound surface a thin layer of a preparation known as "Bipp" (bismuth subnitrate or carbonate one part, iodoform two parts, paraffin in quantity sufficient to make a soft paste). With a gauze swab this paste is rubbed well into the wound, which is then sutured from end to end without drainage. The arm is fixed on a splint and the wound left untouched for 10 days. At the end of this period it is usually found healed or nearly so; another dressing is applied, and allowed to remain 10 days. No further dressing is needed. The absence of frequent dressings is an immense advantage and a comfort beyond words to an anxious, overwrought patient.

Why does Morison's method prove so successful? Is it the free mechanical cleansing of the wound that is of chief importance, or is there some antiseptic or physiological virtue in the "Bipp" as a whole, or in any of its constituent parts? It is almost certain that in the perfect mechanical cleansing of the wound

lies the secret of the method. For I have treated wounds in exactly Morison's method and have omitted the paste, and have seen the wounds heal as kindly as when it was used. If there is a virtue in the paste, in which of the ingredients does it lie? Probably in the paraffin which produces that anaerobic state in which healing can most rapidly take place. Mr. Morison, at my suggestion, tried his methods in two cases, omitting the "Bipp," and he allows me to say that they healed as well as the others treated with the paste.

What disadvantages attach to the "Bipp" method? There have been several cases of bismuth poisoning, and I have seen one of iodoform poisoning. In a certain number of the wounds, especially those which have been treated in France, the paste has been discharged in driblets, or in lumps, after the whole wound has broken down. These faults are due to a wrongful application of the method. Perhaps less than the necessary care has been given to the thorough opening of the wound and certainly far too much of the paste has been introduced. One writer says "the wound must be filled with Bipp"; that instruction is, of course, the very opposite of the truth. If the paste is used at all, only the thinnest smear is applied to the wound surfaces. The excellent and indubitable results of Morison's method have started once again the quest of the healing balm. All sorts of composite unguents and embalming materials have been tried. A very practiced surgeon, Captain Wilson Hey, has used with excellent effect a paste of which boric acid, paraffin, chalk and brilliant green are the ingredients. And good results have also followed the use of chloramine T paste, and of acriflavine paste. Many control experiments by different observers, using the several pastes, or none, are still necessary before we can say if any of them, or any parts of them, are essential to an equal degree of sound healing in the wounds.

Flavine compounds. During the last few months, great interest has been aroused in the surgical world by the writings of Browning and other workers in the Bland-Sutton Institute of Pathology, in praise of flavine as an antiseptic for application to infected wounds. Browning claims that flavine compounds (proflavine, acriflavine) and brilliant green exert a slowly progressive bactericidal action; in concentrations which inhibit and finally kill bacteria, no harmful effect upon the tissues or upon phagocytosis is produced. It is said of the flavine compounds that their bactericidal potency is enhanced by the presence of serum; brilliant green on the other hand is reduced in activity by serum. The experiments of Browning are criticized by Fleming and Tanner and others. Fleming asserts that when many microbes are used in experiments similar to those of Browning the flavine must be in far greater strength than that given as the "lethal concentration" in order to effect sterilization; that in a concentration of 1:2000, flavine completely inhibits leucocytic emigration; that it has, if tested over a period of 24 hours, a greater destructive effect on leucocytes than on bacteria. Carrel has also spoken of the weak antiseptic action of flavine, of its inefficiency under the conditions which really obtain in wounds, of the destructive effect upon the granulations of a wound, producing necrosis, arresting cicatrization and increasing the dimensions of the wound if used for any length of time. We have had in Leeds under the direction of Major Braithwaite and Lieutenant Gruner an experience of the flavine compounds extending over many weeks and embracing a great variety of cases, and a trial of different methods of application has been made (Carrel technique 12 hourly dressings, etc). The *naked-eye* changes are: an early reddening of the surface, a considerable diminution of the exudate, a disappearance of the fibrinous deposit, a firmer consistency of the granulations. If long-continued, the flavine produces a more brilliant red tinge in the wound, a "beefy" look and apparently all processes of healing are held in complete abeyance.

The microscopic changes are first of all a rapid fall in the number of organisms per field, which in several cases is apt to give place to a secondary rise about the fifth or sixth day, in the absence of any necrosis of bone, or retention of clothing or missiles. Then a change is found in the character of the cells, some of which undergo cytoplasmic

breakdown while others show decided phagocytic activity. Then this activity ceases to be manifest, and the bulk of the leucocytes undergo complete necrosis. As the wound improves in appearance so do the cells become few and necrotic. It is possible, Grunre suggests, that the flavine penetrates into the cell substance and alters its metabolism, setting up necrobiosis along abnormal lines, with a resultant flooding of the tissues with abnormal products of metabolism. These arrest the multiplication of the microbes. There may be an added inhibition of the outpouring of coagulable fluids, causing the wound surface to dry up after a few days. These changes appear to be more rapid with proflavine than with acriflavine. Many of the wounds treated with these compounds have been closed by secondary suture, with results to all appearance identical with those which are found after treatment by the Carrel or Morison methods.

Such is a brief statement of the present position with regard to the treatment of war wounds. It must never be forgotten that the time element is always an important factor and that the problem of dealing with an early contaminated wound is not identical with, indeed may be marvelously different from that concerned with a late infected wound. The conditions in the early hours, when the patients are at the casualty clearing stations in France, are very different from those to be combated when the patient reaches a base hospital in England, after the lapse of many days or many weeks. Finally, in the English Army, with the Channel and the long train journey interposed between the hospitals in France and those at home, a new and very difficult set of circumstances must be taken into account.

But, wherever and whenever the patient is seen, the most urgent desire and the paramount concern of the surgeon is to secure closure of the wound. Whatever mode of dressing is adopted, whatever procedure, whether of physiological or of antiseptic principle, is trusted, it is the suture of the wound at the earliest opportune moment that must be the goal of every effort. So far as our present knowledge will allow us to formulate conclusions, the following deductions may usefully be drawn.

CONCLUSIONS

Perfect mechanical cleansing—that is, the excision of all contaminated, infected, or dead parts—the removal of all fragments of clothing (by far the most important of all causes of continuing infection in a wound) and of all projectiles, is the supreme necessity in all cases.

In early cases this may allow of immediate closure of the wound, which will be followed by healing in the great majority of cases, say in 80 per cent or perhaps even 90 per cent of those in which there is no loss of tissue.

In infected early cases the mechanical exposure and cleansing may be followed by a treatment directed to the removal of the remaining infection. Physiological and antiseptic methods have each their advocates. The aim of both is to permit of the earliest prudent secondary closure of the wound. In infected late cases, a thorough mechanical exposure and cleansing of the wound and the parts around will allow of secondary closure forthwith if certain antiseptic pastes are used. Experience shows that similar results have followed upon this mechanical treatment of the wound without the introduction of antiseptics. A further trial in this class of cases may show that the natural defenses of the tissues are ample to deal with the infections then remaining.

It is the natural defensive powers of the body fluids and tissues, of serum and leucocytes, that are the chief agents in finally subduing the bacterial infection in a wound. Sufficient reliance does not appear to be placed upon the stupendous power the body tissues possess for controlling infection.

Finally full emphasis must be laid on the paramount necessity for the complete immobility of wounded parts at all times and on all occasions. So will one of the most powerful agencies making for re-infection and auto-inoculation be kept in check.

II. INJURIES TO THE PERIPHERAL NERVES AND THEIR TREATMENT[1]

NATURE OF INJURIES

THE lesion of nerve trunks as the result of wounds inflicted in war may be of diverse forms.

I. In the majority of cases the nerve trunk has not sustained a primary injury. It may be exposed in greater or less degree in a wound of the soft parts, with or without fracture. If such wounds are gravely infected and suppuration occurs with, perhaps, necrosis of one or of many fragments of bone, the process of healing may be long delayed, and the cicatricial tissue which results will be of exceeding density. The nerve then may come to lie in the midst of a fibrous mass which, undergoing progressive contraction, presses more and more firmly upon the delicate and tender tissue of the nerve. The nerve trunk is strangled, bereft of its due supply of blood, and becomes in consequence functionless. It is impossible before operation to decide in the severer cases whether such a nerve has or has not been completely divided.

II. The nerve fibers may not have been directly, or they may have been only very trivially implicated, but the projectile may have passed so near the nerve trunk as to have opened its sheath. The nerve then becomes adherent to the track of the missile, and a mass of fibrous tissue is found firmly welded on to its lateral aspect. Or, the projectile, in this case a rifle or machine gun bullet, may, at that period of its flight when it has become steady, have cleaved through the trunk of a nerve separating the fibers and severing few or none. Hæmorrhage within the sheath occurs, and a fibrous mass develops in the center of the nerve, causing it to assume a fusiform appearance. There is then a *central neuroma*.

III. The nerve may have been partly severed, say in half its diameter, by a projectile, or a fragment of bone. The gap in the nerve is soon filled up by fibrous tissue which extends widely upward and downward and away from the side of the nerve, so that a hard fibrous *lateral neuroma* is found.

IV. The nerve may be completely severed. In such a case a gap of greater or less length is found between the divided ends. Bridging this interval there may be a connecting strand of fibrous tissue, or a blurred mass of scar material in which both cut ends are lost. In some cases the nerve may appear hard and swollen, and as though its fibers were continuous; but careful dissection will show that there is complete division.

When the nerve has been cut completely across, the upper divided end is soon found to present a characteristic bulbous appearance. On section this is seen to consist partly of fibrous tissue and partly of nerve tissue. From the upper end of any divided nerve, the axis cylinders grow downward tirelessly, each one searching out diligently but blindly the lower end to which it seeks to unite. When the quest fails in one direction and an uncongenial tissue is met, the axis cylinder turns in another direction, searching there fruitlessly again, and so twists itself in ceaseless contortion until a tumor, a *terminal neuroma*, is formed.

The fibrous mass often of extreme density which goes to the making of the bulbous end is probably the reply of tissues to the contact of exposed nerve fibers with them. The peripheral nerves are intruders among the other tissues of a limb, reaching them by a process of invasion from without. The contact of these nerve fibers with any other tissue is prevented by their closure within a sheath whose function appears to be that of an insulator. The end organs of the sensory nerves may indeed be, as W. Trotter suggests, a special mechanism for isolating the nerve fibers, protecting them from actual contact with the tissues. Whenever the nervous system is injured, by accident or design, as in the operations of trephining and laminectomy, there is always a hasty and adequate attempt to isolate the parts again. There is an intolerance of the tissues for contact with nerve matter or conversely of these with other tissues.

Gosset says that the axis cylinder is very

[1] In the preparation of this paper I have received valuable help from my colleagues on the staff of the Second Northern General Hospital, Leeds; Capt. Burrow; Capt. Daw; Capt. Richardson; and D. Cuthbert Morton.

unintelligent. I am not sure that its search for the distal end is stupid, because it is unsuccessful. The search is zealous enough, but the axis cylinder shrinks from ignoble contact with a baser tissue and turns aside to seek elsewhere. The lower severed end becomes thickly covered with a fibrous cap which forms a barrier impenetrable by the axis cylinders seeking so earnestly to find their way along the distal nerve.

1. The *relative frequency* of affected nerves has in our experience been as follows:

Nerve	Per Cent
Musculospiral	25
Ulnar	24
Median	14
Sciatic	12
External popliteal	12
Internal popliteal	1
Upper portion of the brachial plexus	4
Lower portion of the brachial plexus (cords)	7
Anterior crural	1

This corresponds fairly accurately with the experience recorded by Gosset and by Tinel.

2. *Diagnosis.* The following points in the clinical histories are investigated: date of injury; nature of projectile; position of patient at moment of injury; immediate effects; after history (including history of operations performed).

Physical examination consists in —

A. Inspection of the limb to note (1) attitude, contractures (claw hand, etc.); (2) position of wounds and scars.

B. Testing of the efferent impulses. (1) Motor weakness for paralysis, each muscle and each muscle group being tested separately. (2) Trophic and vasomotor disturbances. Non-shedding of epidermis, "glossy skin," ulcers, changes in nails, etc. (3) Changes in deep tissues, e.g., muscular atrophy, fibrillation, bone decalcification, etc.

C. Testing of the afferent impulses. (1) Pain, its character, distribution, relation to hot and cold applications or weather. (2) Loss of cutaneous sensibility, tested by standardized stimuli of special instruments so that the results are strictly comparable. Light touch. Localization of spot touched. Tactile discrimination (pressure, texture, etc.). Stereognostic sense (size and shape of three dimensions); appreciation of compass points applied stimultaneously. Thermal stimuli (hot and cold test tubes). Painful stimuli (pinprick controlled by standardized spring). Roughness (Graham Brown æsthesiometer). (3) Deep sensibility — pressure pain, vibration sense in bones, joint and muscle sense, etc.

D. In the electrodiagnosis, the reactions to the interrupted current are tested by shocks from an induction coil, the electrode being placed upon the "motor point" of each muscle in turn. The current from a secondary coil is always used.

A positive reaction to faradism is regarded as a contra-indication to operation, but failure to respond gives no definite information, for voluntary movement may return, after nerve injury, before the faradic response.

The muscles are next investigated by a constant current. "Polar changes" have been found to be of minor value; they may vary with the local circulatory changes following massage, etc. The character of the contraction is of much more importance. A brisk twitch indicates the probable presence of some conducting nerve fibers in the muscle tested, while a slow "vermicular" response is usually associated with a complete interruption of nerve fibers.

The nerve muscle is next examined by means of a condenser discharge. The method depends upon the fact that a condenser discharge, through a constant resistance, gives a current which varies in duration according to the capacity of the condenser used.

The more severe the damage to the nerve the greater will be the capacity of the condenser required to excite it. Or, in other words, the longer the duration of the current the more chance is there of obtaining a response in such a nerve muscle.

The whole advantage of the condenser method is that a definite measurement of current, or condenser used, may be noted and future progress may be accurately followed.

The condenser method is chiefly used in cases where operation is deferred because some function is found to be present in a given injured nerve. (The work done recently by E. D. Adrian and others shows that the condenser is disappointing in practice; but it,

nevertheless, gives useful information in recording progress.)

Complete absence both of faradic and galvanic response is an indication for early operation. The cases which require careful and repeated examinations are those where there is pressure on the nerve trunk by a contracting scar. In some nerve trunks there is little damage to some of the fibers with total loss in others. Operation must not be deferred too long in these cases, because the fibers with complete reaction of degeneration may never recover on account of a dense scar tissue formation at the site of injury. In other words, the presence of a degree of voluntary power in some individual muscles of a group supplied by a damaged nerve is no sure criterion that the paralyzed muscles will recover without operation.

It is most important that nerve injuries should be re-examined at frequent intervals and carefully detailed records of motor power, sensory changes, and electrical reactions kept. In this way treatment may be modified according to progress.

In operations upon nerves where a diagnosis of total loss in some fibers only has been made, it is our practice to test the exposed nerve both above and below the site of injury at the time of operation. For this examination special sterilizable electrodes and long connecting cords which can be boiled, are used. The nerve is gently lifted upon two small glass hooks and a very weak faradic current employed.

The most accurate anatomical arrangement of fibers may be noted by this means and the knowledge used to secure perfect adaptation in nerve suture. The diagnosis is often completed during a period in which massage, baths, and electrical treatment are employed to improve the local circulation, and splint treatment adopted to relax affected muscle groups and to overcome contractures. The distinction between anatomical and physiological division is not made before operation.

The main difficulties encountered in arriving at an exact diagnosis are in cases where there are wasting and stiffness from disuse, circulatory disturbances, contractures, destruction or adhesion of muscle and tendon.

Operation is decided upon in the following circumstances: (1) in cases of complete division; (2) in cases of incomplete division, where progress is arrested; (3) where there is severe neuralgic pain, "causalgia."

Operation is deferred (1) for one month after the closure of the wound where soft parts only are injured; (2) for two or three months after complete closure of the wound where bone has been involved; and (3) definitely so long as progressive signs of recovery in nerve functions continues.

The suture of the nerve may have to be delayed until unsatisfactory joint conditions are improved. Contractures of the knee, for example, should be corrected before the sciatic nerve is sutured, otherwise the nerve would be in danger of rupture if the deformity were subsequently rectified. In other cases the nerve may be sutured, and the joint dealt with at the same period, and subsequently. It is of the first importance to start active measures to prevent or remove stiffness and deformity in the parts supplied by a wounded nerve. This can often be done for many weeks before it is possible to repair the nerve. It is not sufficiently realized that a nerve to be of use after suture must act upon live and supple tissue. Joints and muscles must be kept ready for the nerve impulse which some day will come to them again.

When the diagnosis of a nerve lesion requiring operation has been made, the earliest prudent occasion must be chosen for operation. In both the French and British armies nowadays the suture of a divided nerve is performed in those most advanced operating centers where the first deliberate toilet of the wound is possible. It is realized, of course, that very often a complete union between the severed ends cannot result, but, even if the operation prove eventually to be a complete failure, the subsequent operative procedures are certainly easier, and it is a satisfactory thought that a chance has been given for healing to take place.

In the great majority of nerve lesions dealt with up to recent times, the wound inflicted by the projectile has suppurated. We have learned by bitter experience in this war what this means. It means that the bacterial flora

in such a wound are numerous and, potentially at least, of great maligancy. It means that even a simple operation upon a wound which still discharges pus may arouse a flaming infection and be a cause of tetanus or gas gangrene. Mere passive movement of a joint grown stiff by inactivity may bring about an attack of tetanus even though the adjacent wound has healed. In many cases an injury to bone may have been inflicted at the same moment as the division of the nerve; this is, of course, frequently the case when the musculospiral nerve is implicated. Many loose pieces of bone may remain as sequestra in the wound and may need removal or may escape spontaneously from time to time. In all such cases, operation upon the nerve must be deferred until the wound has been soundly healed for some weeks; no rule is more binding upon the surgeon than that. During this period, which may be protracted, the most diligent attention must be given to the limb, especially to those parts, muscles and joints, distal to the injury. The paralyzed muscles must be kept in a position of relaxation. This may be easy, as in those cases where the musculospiral nerve is divided; it is often difficult, as in cases of injury to the median nerve; it is sometimes impossible, as in dual or triple lesions of nerve trunks. But difficult or easy, the best possible must be done, for the final functional result in respect of quality and of rapidity depends in no small degree upon the early care of the parts deprived of their nerve supply.

Special and unremitting attention is given to the joints, which must always be kept supple. It is remarkable how quickly the fingers, for example, become so stiff that forced movement is an agony. Every day, many times a day, all the paralyzed parts must be freely moved to their full range, and the patient must be instructed to attend to this matter unceasingly. The most perfect nerve healing is robbed of its value, if through long disuse the muscles, whose innervation is restored, have lost their power to act, and if the joints are so firmly anchylosed that even passive movement cannot bend them fully. The value of these preliminary and preparatory measures cannot be overestimated.

When the operation actually takes place it is important to observe certain essentials to success. There must be the most perfect and scrupulous asepsis and the most gentle handling. The finger should never be placed in the wound. All dissection should be carried out deftly and neatly; the most diligent care must be taken never to bruise the nerve by seizing it, however gently, in forceps. The nerve must never be twisted, or torn or stretched, or unduly separated from its bed. Other structures must be dissected from the nerve; the nerve must not be dissected from them. The nerve must not be stripped bare for too long a distance, otherwise it will be devascularized, and recuperative processes will be slow or absent. The wound, as a whole, and the nerve in particular must not be allowed to dry or to be chilled. The most dainty and precise movements are necessary throughout and every bleeding point must be thoroughly secured. There are, of course, the observances that go to make up the ritual of every well-trained surgeon; their strict acceptance is more necessary here than in almost any other operation, if the most rapid and the most flawless recovery is to be made certain.

As a rule a tourniquet is undesirable, for two reasons: it is possible to harm the nerve, or other nerves in the limb, if the rubber band is applied too tightly, and for the long period sometimes necessary in this procedure; and when the operation is complete and the tourniquet removed there will probably be an escape of blood into the wound, a thing in these cases most undesirable. In these wounds not infrequently there is a good deal of young fibrous tissue from which free oozing may occur in the period of hyperæmia which follows removal of a tourniquet.

The incision is designed to fall on the skin at some distance from the original wound if possible; very often a flap will occur from the making of a curved incision. The planning of the incision gives scope for one's knowledge of anatomy; it is so arranged that no small nerves are wounded. Major Jamieson has shown that when the median nerve is injured in the forearm, it may sometimes be more thoroughly and successfully dealt with from the outer instead of from the inner side of the

Splint designed by Dr. Cuthbert Morton for application to cases of musculospiral palsy in order to secure extension of wrist and grasping position of the hand.

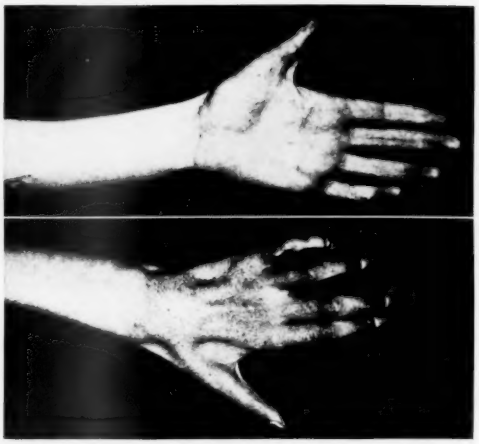
flexor carpi radialis. So, too, when the musculospiral nerve has been injured high up on the outer side of the forearm, Dr. Cuthbert Morton suggests that instead of cutting through the outer head of the triceps, it should be reflected completely from the humerus. Not only does this cause less damage to the muscle tissue but it also exposes the nerve and its branches as well as the profunda artery to a very high level without undue risk.

The nerve trunk is sought above and below the point of severance, and is traced downward and upward to the gap. Swift neat little cuts with a very sharp scalpel damage the tissue to the smallest possible degree. The surgeon must avoid contact of his fingers with the wound; it is clumsy and inartistic to prod about among muscles in the hope of feeling the nerve. It is his business to know before he begins these operations exactly where the nerve lies, and he should always be able to cut directly down on it. When the injured part of the nerve is exposed, it is usual to find a bridge of fibrous tissue between the ends; the proximal end being often very turgid and bulbous. If the gap between the refreshed ends of the nerve is likely to be wide, now is the time for stretching the nerve, so as to lessen the interval as much as possible. This is done with infinite gentleness and care by seizing the fibrous band between the ends, and drawing steadily upward and downward, always remembering to make the pull in the line of the nerve trunk and to avoid twisting. The fibrous band is now split longitudinally, and then its ends are divided, above in one direction, below in the other, so that to each cut end of nerve a fibrous tag is attached by means of which the nerve ends can be drawn together. Progressive transverse cuts are now made into the nerve ends until on the

Case of division of inner cord of brachial plexus to show typical position of the hand.

Sciatic causalgia. Paralysis of both groups. Nerve operated on and symptoms (in this case) were relieved at once.

Case of division of median and ulnar nerves. This photograph shows the characteristic skin condition which results from non-shedding of the epidermis.



Case of division of median and ulnar nerves, same case as in preceding photograph, showing the rapid trophic improvement after operation.

cross section nothing but nerve fibers are seen. Every tiniest particle of fibrous tissue must be removed or the operation will fail. The axis cylinders coming from above must have free entry into the nerve below; otherwise in their downward development they will lose their way, and restoration of the nerve function will not take place. When the nerve ends are duly prepared they are brought into apposition with the greatest care. A series of very fine catgut sutures holding only the nerve sheath are inserted at intervals round the circumference of the nerve. A suture is never passed through the substance of the nerve itself. In uniting the nerve ends, it is of the first importance to avoid axial rotation. We know now that there is a differentiation of function within each nerve, and it is, therefore, strictly necessary to unite corresponding bundles of fibers. A nerve does not act as a whole, but consists of a multitude of strands each with its proper and restricted function. Unless nerve bundles which were originally continuous are brought accurately together by suture, the nerve is compelled to rearrange the functions of its several parts. This it can, and no doubt frequently has, to do. An examination of many cases shows, however, that a perfect and flawless recovery after a nerve suture is unusual, and it is at least a tenable belief that this inadequacy or delay in recovery is due to a want of recognition by the surgeon of all that is needed in the technical part of the operation. My colleagues on the staff of the Second Northern General Hospital in Leeds are obtaining results which in rapidity and completeness would have been thought impossible before the war.

There is rarely any difficulty in obtaining accuracy of apposition without tension. If, however, the nerve ends cannot readily be brought together, various procedures may be adopted to shorten the course of the nerve. The nerve may be dislocated from its bed and laid in a new and shorter line. The ulnar nerve, for example, may be brought to the front of the inner condyle. Or flexion of the limb may be enough to allow of easy approximation. In the case of the median nerve divided

Case wounded by bullet, November 2, 1914. Inner cord completely divided with artery. Nerve suture, December 8, 1914. May 25, 1915: Function almost completely restored. June 26, 1915: Function still improving. August 30, 1915: Patient returned to duty. The only abnormal remainder was some hyperalgesia in palm. All muscles perfect.

low in the forearm, flexion of the wrist will give an inch or more additional reach. In other cases the limb may be shortened by removing an inch or two of bone. It is desirable to avoid a subcutaneous course in all transferences to new positions. The nerve after suture should be brought to lie in a bed of healthy tissue. It must be placed between muscles, and away from all contact with new connective tissue, which will adhere to it, and hinder its union, or cripple its subsequent action.

It has been the fashion with many surgeons to surround the sutured nerve with some material supposed to have protective virtues. A piece of a vein, the saphenous for example, is threaded over the upper cut end of the nerve before suture, and after these ends are approximated the vein is drawn downward and made to surround the line of suture. In other cases, a piece of fat dissected from near the wound, or from another part, is wrapped round the nerve: fat being supposed to be capable of insulating the nerve in its new position; or a layer of fascia may be used, or a piece of Cargile membrane. The value of all such methods is open to serious question; it is certain that they are sometimes harmful, it is doubtful if they ever help. They prevent access of blood to the nerve by new channels, they cause adhesions and compression of the nerve, and at times they are discharged from the wound almost unaltered. It is better to avoid such membranes, and to be content with insuring that the nerve is laid along a path of uninjured tissues. Where end-to-end suture is impossible a variety of other procedures may be attempted. A nerve-graft, taken from a neighboring cutaneous nerve from the radial, the internal cutaneous of the thigh, or an intercostal nerve may be used. Experience on the human subject has not yet enabled me to determine the value of this procedure. In experimental work it answers well, but I have rarely, if ever, seen a result which could be claimed as satisfactory. Colonel Mayo Robson[1] has had one of the very few successful cases. Nerve-anastomosis has been tried in a number of cases. The divided ends of a nerve are implanted into the side of a near-lying nerve: the ulnar into the median, for example. This has been done both with, and without, section of the nerve fibers of the intact nerve. All such procedures are worthless and cannot be too strongly condemned. I have never seen any good come of them: indeed, nothing but harm could conceivably result from section of a healthy nerve. And if it is allowed,

[1] Brit. M. J., 1917, i, 117.

Case of paralysis of both median and ulnar nerves, due to wound caused by a rifle bullet.

as it must be, that a nerve consists of many separate strands each with its own special and exclusive function, it is certain that permanent damage is inflicted by this method. There is no justification for this procedure nowadays, and it should be cast out among forgotten things. Lengthening of the nerve by turning down a strand from the upper divided end, or the bridging of the gap by strands of catgut, are methods with nothing whatever to recommend, and everything to discredit them.

Happily the resources of surgery are not at an end in all cases where union of divided nerves is impossible. Tendon transplantation, especially in the case of the musculospiral nerve, and the posterior interosseous, gives results which in point of function are almost as good as those which come from nerve suture, and in point of time are much quicker. It is chiefly in the musculospiral nerve that large gaps are found, a piece of the nerve having been blown completely away. In such cases tendon transplantation gives excellent and speedy results. When the posterior interosseous nerve is wounded it is not worth while attempting to suture the nerve. The results in such cases are slow, and not always perfect.

In those cases where the nerve is partly divided, strands of intact fibers still remaining, the severed fibers are united in the same careful way, and the normal strand of the nerve bent upon itself so as to allow easy approximation of the cut portions of the nerve. In perhaps the majority of operations upon nerves, there is no division of fibers, but a length of the nerve is imbedded in dense fibrous tissue. These cases give most excellent results. The fibrous tissue which so intimately surrounds the nerve is dissected away little by little. The nerve when first freed is seen to be white and shrunken; but within a few minutes it expands and takes on its normal color. I had several cases of this kind in the Boer War, and the results at this long interval are perfect. It is in these cases that advantage may sometimes be taken of the method of fat transplantation, or of nerve dislocation.

After-treatment. (1) *Postural.* In those cases where flexion of a joint has been necessary to allow approximation of the cut ends of nerves, the position is maintained for a period of six weeks. By this time union of the severed ends is probably well advanced. Extension by slow and most cautious degrees is then begun. If the knee has been flexed to allow the sciatic nerve to be united, the patient can walk with a boot and leg irons, keeping the position unaltered for say two months. Wherever possible a splint is applied which produces a "relaxation position." In the case of the median and ulnar this is difficult, but is best secured by molding a "ball splint" to the hand of the patient. Every such splint must be made for the individual. In the case of the musculospiral, it is very simple. The "cock-up" splint designed by Colonel Sir Robert Jones is excellent, if the lesion of the nerve is below the branch to the supinator. It maintains hyperextension of the wrist, and reaching only to the heads of the metacarpal bone it allows a forward bend of the metacarpophalangeal articulations. The thumb lies forward and a little inward, so that the position of the whole hand is very much that assumed when a bottle is grasped. If the lesion is above the nerve to the supinator brevis it is essential that this muscle also

Case wounded by bullet, August 8, 1916; examined and photographed February 9, 1917; operated upon February 12, 1917. Ulnar nerve involved in dense scar (functionless); freed. Median nerve and internal cutaneous completely divided and sutured. Two incisions shown. Through the upper the projectile passed; through the lower the nerve operations were performed. Top picture taken February 2, 1917.

Second photograph (at bottom) taken June 6, 1917. Some sensory return in addition to recovery from trophic changes; flexion at wrist present.

August 28, 1917: Almost complete recovery except in hand muscles.

should be relaxed. For this purpose Dr. Cuthbert Morton has devised a splint which retains the forearm and hand in supination while the wrist is fully extended, the fingers being at the same time kept in the bottle-grasping position.

Similarly in cases of injury to the external popliteal nerve, relaxation of the corresponding muscles may be secured by the boot which has been introduced by Dr. Cuthbert Morton in order to allow the patient to walk about with the foot in permanent dorsiflexion.

2. *Massage and electrical treatment.* These measures are restarted about two weeks after operation with all due precautions and safeguards. If a splint has been applied to secure the "relaxation position" it must not be removed. Indeed, not for one moment at any time must paralyzed muscles be stretched. An overstretching of a few minutes may call for diligent treatment of many weeks before the harm is undone. If a splint needs removal for purposes of cleanliness, the patient must be instructed beforehand to keep the limb in the exact position required. In the case of musculospiral palsies, the hand drops into the correct position if the flexor surface of the forearm is *upward*.

Results. Our records are as yet necessarily incomplete. Recovery in the case of the musculospiral has begun within 9 weeks; in the case of the ulnar within 3½ months; in the case of the median in 4 to 5 months. In one case of division of the inner cord of the brachial plexus, recovery in all anæsthetic areas, and a degree of recovery in all muscles occurred within 5 months. Recovery in the case of the sciatic nerve is slower. Something depends, it is sometimes said, upon the length of time elapsing between division of the nerve and its suture. My colleague, Captain Richardson, has, however, united the ends of an ulnar nerve cut across 15 years before and signs of returning function were seen in about four months. The duration of the disability is, therefore, no bar to successful nerve repair.

The functions return usually in the following order: (1) trophic and vasomotor function, (2) deep sensibility, (3) tactile discrimination and localization, (4) motor power, (5) cotton wool sensation.

Perfect restoration of function has been most nearly approached in the case of the musculospiral nerve. In other nerves with more complex distribution, perfect recovery will depend upon a recognition of the functional localization within the nerve trunk, in addition to the most scrupulous observance of all those technical details without which there will always be something less than perfection.

In the diagnosis and treatment of an organic lesion of a nerve, it should never be forgotton that there may be superadded a functional disability. It is advisable at every stage to get rid of the functional in order properly to appreciate the organic. This is particularly important when the organic lesion is well on the way to recovery. Thus, in a recovering lesion of the inner cord of the brachial plexus, it may be impossible for the fingers to be flexed until re-education has trained the laggard muscles into obeying orders from headquarters.

SUMMARY

The following summary may be given of our experience up to the present time.

1. The earliest examination should be made of all wounds in which division of a nerve trunk is probable. If at the casualty clearing station such a lesion is found, end-to-end suture should be adopted forthwith. This is more likely to be possible in cases where primary suture of the wound, after excision, is found practicable.

2. If secondary suture of the wounds, after the Carrel-Dakin method has been practiced, is to be undertaken the union of divided nerves should be secured at the same time.

3. If these methods have been attempted and have failed, they do not prejudice the later union of the nerve. On the contrary they probably insure that an easier and more satisfactory operation can then be practiced.

4. Throughout the whole period before late nerve suture is attempted, the strictest attention must be paid to the relaxation and nutrition of all paralyzed muscles, to the maintenance of suppleness in all joints moved by these muscles, and to the preservation of the integrity of the skin.

5. Operations upon nerve trunks demand the most scrupulous observance of the ritual of asepsis. There must be the greatest gentleness of manipulation; the nerve must not be injured by instruments or by the surgeon's finger; it must not be separated from its sheath or disturbed overmuch from its bed; it must not be chilled or allowed to dry. All sutures must be of fine catgut and introduced with most punctilious accuracy. Axial rotation of the nerve must be avoided. The cut ends of the nerve before approximation must show clearly the fibers of which the trunk consists.

6. Nerve grafting is of little or no value; nerve anastomosis is to be sharply condemned; the turning down of flaps from the nerve to bridge a wide gap is useless.

7. Tendon transplantation is of great value in cases where nerve suture is impossible or where suture has given a result not entirely satisfactory.

III. GUNSHOT WOUNDS OF THE LUNGS AND PLEURA[1]

THE mortality of chest wounds in all zones of the army is extremely difficult to ascertain with anything approaching to accuracy. Pierre Duval, whose work on the surgery of the lungs during this war has been characterized by originality, insight, prudent courage, and great technical success, has gathered together the records from many parts of the French Army. Of a total of 3,455 cases there were 688 deaths, roughly a mortality of 20 per cent. But the mortality differs, as may well be imagined, at various parts of the line of communications. At the aid posts it is terrible, not less it is asserted than 25 to 30 per cent. At the ambulance chirurgical automobile, or casualty clearing stations, the mortality is about 18 to 20 per cent. In the base hospitals the death rate is about 10 per cent. There is, it will be seen, a progressive diminution in mortality from the front to the base. Pierre Duval scrutinized these figures in the following remarkable way:

At the aid posts, where the mortality is 25 per cent, there will remain alive of 100 patients, 75. At the ambulance, of these 75, 20 per cent will die and there will remain 60 patients. At the base, of these 60, 10 per cent will die, so that finally 54 cases will survive.

Two series of cases falling under individual observation may be quoted. Gregoire records a total of 404 cases of chest wounds, pure and simple, i.e., without other injury, with 47 deaths, a death rate of 11.7 per cent. Of these, 57 patients were operated upon for empyema, with resection of the rib and drainage; 26 died, a mortality of 45 per cent.

DePage, at his well-known hospital at La Panne, which combines the functions of field ambulance, casualty clearing station, and base hospital, receiving patients a few hours after injury and retaining them as long as is necessary, records 320 cases of pure chest injury with 59 deaths, that is, 18.4 per cent. Within the first 24 hours 9.4 per cent of cases died, chiefly from hæmorrhage. In the later stages 10 per cent of the survivors died, chiefly from sepsis.

Elliott[2] estimates the mortality of chest wounds in the British Army in France, at the field ambulances and casualty clearing stations at from 20 to 25 per cent, of which 10 to 15 per cent are the early result of shock and hæmorrhage, while 10 per cent die of sepsis. The mortality on the lines of communication is about 5 per cent; all these deaths are from sepsis. The mortality of cases reaching England is small.

All observers are agreed that there is a difference in the mortality according to the projectile inflicting the injury. If a rifle bullet causes the wound, the condition resulting is either very serious, if a large vessel is struck, or very benign if the lung tissue is traversed without serious vascular injury. Wounds with high explosive shell, the fragment causing the wound being irregular and jagged, when pieces of clothing or of skin are driven deeply in, are always serious by reason of the infection that is so prone to follow.

Rouvihois in 102 cases found the following: In 60 cases where the projectile was retained, there were 27 deaths; in 26 of these the wound was caused by shell, in one case by rifle bullet. In 42 cases of perforating wounds, there were 10 deaths; in 9 of these the wound was caused by shell and one by rifle bullet. These figures are a truly remarkable comment upon the influence of the projectile in determining the mortality.

Death occurs chiefly from two causes: from hæmorrhage or from sepsis. Hæmorrhage is fatal early, generally within the first 24 or 48 hours. Sepsis proves fatal at a later stage, generally from the seventh day onward. The most fatal cases are those where there is a gaping wound of the chest so that the lung is freely exposed. The mortality in cases where the chest wall is closed behind the projectile is rather less than one-half of that which results when there is an open wound. Captain H. Henry in 100 postmortem examinations made upon patients with chest wounds who reached a base hospital in France found that the great majority of deaths were

[2] Lancet, Lond., 1917, ii, 371.

[1] Read before the Clinical Congress of Surgeons of North America, October 22–26, 1917.

due to septic infection. Only 4 patients died from hæmorrhage, and in 3 of these the hæmorrhage was secondary in character and was induced by sepsis.

PATHOLOGICAL ANATOMY

The injuries inflicted by a projectile entering the chest may be considered in their effects upon (a) the chest wall, (b) the injured lung, (c) the opposite lung.

The chest wall. The damage done to the chest wall may be of the most diverse forms. There may be a clean penetration of the thorax from front to back, the projectile, in this case a rifle bullet, cleaving a way through all the tissues it meets here, precisely as it does when the thigh, or the soft parts anywhere are pierced. In many of these cases, however, and in a still larger number when there is a shell-wound, there is a fracture of one or more of the ribs or of the scapula. Fragments of bone, tiny spicules, or larger pieces are carried into the chest, and at a later operation may be recognized and removed either from the lung itself or from the pleural cavity, especially in the cul-de-sac above the diaphragm. The same results follow this scattering of the bone into the lung as occur when there is a compound fracture of the long bones in the limbs. Each bony sequestrum becomes itself a projectile driven with force into the tissues, and carrying with it a capacity for infection, and inflicting a grave injury upon all the parts through which it tears its way. The conditions so produced are serious and long continued.

In severer cases a part of the chest wall may be destroyed, being driven inward by a massive piece of shell casing, or being swept away by a glancing blow. Few cases reach a base hospital in France, and still fewer, of course, in England, where any large portion of the parietes is lost. Such cases die in advanced stations up the line, from shock or from hæmorrhage. The few that I have seen at base hospitals were all heavily infected, and suffered much distress. Their condition is a powerful argument in favor of the early closure of all parietal wounds, wherever possible.

The injured lung. The effects produced in the lung are strictly comparable to those produced in other parts of the body by the various forms of projectile. The points of entrance and of exit in the case of perforating wounds bear all the appearances of those seen in the soft tissues of the thigh. The entrance wound is small, even punctate; the orifice of exit is larger, more irregular, and bears signs of greater injury, and of a tendency to protrusion of wounded parts. Along the track of the missile there are the same evidences of diffused injury. The parts around are bruised and lacerated, there is a hæmorrhagic pulmonary infiltration of varying, but often wide, extent. The part of the lung giving onto the track is contused or dead, and such tissue offers here as elsewhere the most favorable opportunities for bacterial invasion and growth. Postmortem examinations of wounded lungs generally show that the track of the projectile, whatever it may have been, is rectilinear. There are no fissures or rifts radiating from the main track, nor any hidden pockets shut off from the central channel. Several tracks may be found in close approximation when many fragments of metal have entered. The bronchi of large or medium size seem to escape injury in the majority of cases. In the path of the projectile, blood is extravasated in the earliest hours; in later stages pus may be found.

The injury to the damaged lung is not, however, confined to the path of the bullet, and the parts immediately adjacent. The distant portions of the lung or the pleura bear traces of lesions due to the force with which the parts are struck. There may be hæmorrhages by *contrecoup*, in the upper lobe if the lower is wounded or in the lower if the upper is injured, or in both if the projectile has passed near the base of the lung. These, as Duval has shown, may be recognized at once by the opacity seen on the radiograph; and I have found in later operations many recent adhesions of the pleura over parts that could by no possibility have met with a direct assault. These conditions are of the same order as those described in an early fatal case by Latarket. He found a massive congestion of the whole lung, a sort of diffuse hæmorrhagic infiltration, in a case in which a bullet wound was inflicted at close range.

Such meager postmortem experience as exists confirms the impression that is derived from the clinical examination of operated cases: that wounds of the lung heal rapidly and kindly.

The opposite lung. It is a new experience, gained during this war that the opposite lung suffers damage also. Such lesions are frequent; in the severer cases probably constant. They consist in small or large hæmorrhages, beneath the pleura or in the substance of the lung. These may be followed by filamentous or by firm adhesions between the visceral and parietal pleura. In a late stage the lung may present all the evidences of a bronchopneumonia, at one point, or in many. The increased activity imposed upon the lung by the restricted function of that which has been wounded, no doubt renders it an easy prey to any malady. The presence of an infected mucus in the trachea may lead to the inhalation of purulent or septic material into the uninjured lung. These conditions often improve very rapidly when the injured side is treated by aspiration of a large hæmothorax, or free drainage of an empyema.

Hæmorrhage. When a missile enters or traverses the chest, any of the vessels contained therein may be lacerated. If the larger vessels in the mediastinal cavities or in the root of the lung are divided, the loss of blood is so copious and rapid that death results at once and the patient does not reach even an advanced aid post.

In the cases not immediately fatal, the blood comes, in the very great majority of cases, from the lung tissue. Henry and Elliott as a result of careful investigation of the thoracic walls and the lung in 78 postmortem examinations, made on the subject of hæmothorax, came to the conclusion that the bleeding had been of pulmonary origin in the great majority of cases.

Apart from the cases dying instantly from hæmorrhage, the deaths in the first 48 hours are all due to loss of blood from lung tissue. Both in the French and the English armies, precocious operative measures are being adopted in such cases with a degree of success that encourages a wide adoption of this practice. If death does not occur speedily from hæmorrhage, a recurrence of bleeding is not often seen. Patients rarely die from hæmoptysis, and secondary hæmoptysis is extremely infrequent. The occurrence of hæmorrhage through the wounds of entry or of exit is probably responsible for the erroneous belief that it is from the chest wall, from the intercostal vessels, that the blood is lost.

Dolbey records one very remarkable case of gross hæmorrhage resulting from a wound of the axillary vein. The chest filled with blood from the torn vessel, but after two large aspirations the wound in the vein healed. There was also an aneurism of the axillary artery which was successfully treated by ligature of the subclavian artery.

Hæmothorax. When blood escapes into the pleural cavity, what happens to it? According to Elliott and Henry, "it appears probable that clotting always takes place — and very early — through the action on the blood of the ferment liberated at the surface of the wounded tissues. The clot may be (a) complete and massive, forming a soft and persistent clot, (b) massive but with an early and fairly extensive separation of the yellow serum from the clot, (c) interfered with by the churning movements of respiration (and of the heart?) so that the fibrin is whipped out in layers which cover the pleural surfaces, while the serum retains most of the red corpuscles in suspension."

The amount of blood extravasated into the pleural cavity varies very much, from a few ounces up to 4 or even 5 pints. The escape of blood is hindered and at last arrested by collapse of the lung, and by the pressure exerted by the blood which has already flowed into the pleural cavity. The response of the pleura to the contact of blood is expressed in an inflammatory reaction which also helps in some degree to seal the leaking orifice though it also increases the mass of fluid lying in the chest. The admixture of fluid effused from the pleura accounts for the fact that in many cases the condition of the combined fluids does not conform with that seen when only blood is extravasated.

Hæmothorax in itself, though disabling enough and productive of such general effects as the loss of a large quantity of blood neces-

sarily entails, is not dangerous to life apart from infection. The bacteria chiefly responsible for this hazardous complication are according to Duval:

A. Aerobic
   1. Derived from the respiratory tract
      Pneumococcus
      Staphylococcus
      Bacillus tetragenus
      Bacillus of Pfeiffer
   2. Derived from the wound
      Streptococcus
      Bacillus coli
B. Anaerobic
      Bacillus of Welch
      Bacillus sporogenes

The most common association is of the bacillus coli with the gas gangrene bacillus.

The frequency of infection may be gauged from the figures given by Captain Henry. Out of 500 specimens of fluid obtained by tapping, in the ordinary routine of work, 195 were found to be infected, and of these 87 were infected by anaerobic organisms. These may be distributed from the first throughout the bulk of fluid, or they may be retained in the fibrinous mass at the bottom of the pleura for a longer or shorter period; being disseminated at last through the supernatant fluids as a result of the respiratory movements. This accounts for the fact recorded by Elliott and Henry that the first puncture made for diagnostic purposes was found to be negative in 50 per cent of pure infections by anaerobic bacilli. The syringe introduced into the upper fluid part of the hæmothorax may discover no organisms, whereas one made lower down into the more solid fibrinous clot may give positive results. The infection may be derived from the projectile or clothing carried into the wound at the moment of the infliction, or may be derived at a later stage from the focus in the lung, or from the suppurating external wound. Pierre Duval, in the Somme battles, had charge of 193 cases of gunshot wound of the chest. Of these, 49 were due to bullet wounds, none of them had an infected hæmothorax; there were 33 perforating wounds from shell fragments and among these were 6 of infected hæmothorax, 18 per cent; there were 111 penetrating wounds, among which were 28 of infected hæmothorax, 24 per cent.

TREATMENT

Upon one point all those who have been responsible for the treatment of a patient with a chest wound are in complete and confident agreement. The earliest and the most perfect immobilization is necessary. Movements of all kinds are to be avoided, and therefore retention of the wounded man at the casualty clearing station for many days is a paramount necessity. The fact that in the first two days the deaths are due chiefly to hæmorrhage and in later stages to sepsis must direct the timely and appropriate treatment. Early operations for the purpose of arresting hæmorrhage from the lung tissue have been tried only in certain hospitals in either the French or the British zones; but so far as the results of the work have gone, they appear to justify a continuance, and indeed a general adoption, of the principle of early direct treatment of the wound. It is I think largely owing to the advocacy and to the successful practice of Pierre Duval that an earlier surgical attack is now considered necessary upon the graver kind of lung case.

Immediate intervention, according to Duval, should comprise:

1. Closure of the chest wall in cases of "open thorax."
2. Thoracotomy with suture or plugging of the lung in case of grave hæmorrhage or of threatening asphyxia.
3. Treatment of progressive surgical emphysema.

1. Closure of the chest wall, an operation practiced by Larrey in the Napoleonic wars, has, as its aims, the suture of the muscles and skin in order to avoid traumatopnœa, pneumothorax, and a continuing infection of the pleura from the suppurating external wound. The principles are those guiding the surgeon in all similar wounds elsewhere; the results in the saving of life and suffering are incalculable. The gravity of the cases of "open thorax" can hardly be exaggerated. When a part of the chest wall has been torn away, the lung, often bruised or lacerated, is exposed. It retracts toward the hilum and leaves, gap-

ing and bare, a huge cavity wherein putrefaction may occur, and a large surface from which absorption can take place. It is most urgently necessary to close such ghastly wounds if it is physically possible. Gregorie has accomplished this in 17 cases of which 16 recovered.

2. Thoracotomy is formally indicated in all cases of wound of the lung causing hæmorrhage. Suture of the lung tissue affords perfect hæmostasis. When any foreign body, projectile or sequestrum, is felt, the lung is incised over it if necessary, and after extraction of the foreign body, the wound is stitched up accurately. Any blood lying in the pleura is carefully evacuated, perfect cleansing of the cavity is insured, and the wound is closed, it may be after a gentle wiping of the parts with ether. There is no need for drainage.

3. In the treatment of progressive emphysema, closure of the wound in the lung will shut off the channel through which the air escapes into the tissues. Multiple skin incisions will relieve the tissues already distended and crepitant. In cases of simple penetrating wounds, a cleansing and excision of the wounds followed by a complete approximation of the edges is all that is necessary. In many cases, even excision is not required; the points of entrance and of exit may be cleansed and covered with a sterile dressing.

When a hæmothorax is present, no interference as a rule is needed for some days. There may be exceptions to this rule when the rapid or the large accumulation of fluid is causing urgent dyspnœa which threatens the life of the patient. The dangers of early aspiration of the fluid are, of course, related to the re-opening of the pulmonary wound, which, lightly sealed, may bleed afresh, as the lung expands. At the end of a week or thereabouts, aspiration of the blood has probably a most beneficial effect upon the lung, allowing it to expand much more rapidly than would otherwise be possible and preventing the formation of those dense crippling adhesions which may embarrass the free action of the lung for a long time to come, or even permanently. Operation on cases in England, in which the blood has been left in the pleural cavity, reveal an extreme density and a wide extent of adhesions. X-ray examination also demonstrates the firm union that is formed between the two layers of the pleura. Withdrawal of the fluid is therefore most desirable; its replacement during aspiration by oxygen allows more fluid to be taken, and causes the minimum of distress to the patient.

In cases of large hæmothorax which presumably have remained sterile and in which no active treatment has been adopted, there is a protracted period of incapacity of the lung. I have seen such cases many months after the injury in which the percussion note was still dull, the breath sounds were absent or diminished, the chest flat and the respiratory movements very restricted. On examination by X-ray a greatly thickened pleura was diagnosed and immobility of the diaphragm observed on the affected side. If aspiration is performed the appearance of the fluid gives valuable information as to its condition in respect to bacterial infection. If the fluid closely resembles new port wine in color, it is free from infection; if it is clear and almost colorless the amount of blood contained is small; most of the fluid is then the result of a pleuritic effusion. A turbid fluid like weak cocoa, or an effusion with any suspicion of offensiveness, indicates that infection is present and that the condition is one to be treated as an empyema.

When a hæmothorax has become infected, then thoracotomy is necessary. In the early period of the war the operation was practiced on the lines of the civil operation for empyema. A short piece of rib was excised, the putrid and most offensive fluid evacuated, and a large drainage tube introduced. Such cases remain sometimes for weeks, even for months, with open wounds. Tuffier has modified, profoundly for the better, the treatment of these tedious and most trying cases by adapting to their needs the Carrel-Dakin technique. The operation, in so far as resection of the rib and evacuation of the fluid are concerned, is precisely similar to the procedure in cases of empyema. But instead of one large tube, several small tubes threaded with wire are placed over the cavity at well judged intervals. Their position and proper dis-

tribution may be confirmed if roentgenogram is taken. A little loose gauze is packed into the wound and a safety tube, for drainage of excess fluid, lies in one angle of the incision. Dakin's fluid is instilled in the usual manner. At the end of ten days all discharge (there is rarely more than an extremely small quantity after the first two days) has ceased, and the tubes are therefore removed and the wound closed.

There is no doubt that many cases of suppurating hæmothorax would do better if operated upon quite early, by a wide opening of the chest, and a complete clearing away of all masses of clot and pleural lymph often so tenaciously adherent, and by removal of any projectiles. Patients not operated upon or operated upon by the older methods linger on in unsatisfactory conditions for such long periods at home, that every fair opportunity that offers for curtailing the tedious and not wholly safe period of their convalescence must be embraced. The Carrel-Dakin technique will here find one of its most valuable indications. This is only to bring the treatment of wounds of the lung into line with that practiced elsewhere. The surgeon no longer allows infection to be well established in the wound; his aim is to attack by approved methods (the free opening of the wound, the excision of all dead or contaminated tissue, the removal of all fragments of clothing, of all projectiles and of all foreign bodies) and then to secure the earliest possible closure of the wound which remains. No less an ideal and no less scrupulous a practice should guide him also in the treatment of wounds of the lung and pleura. The time has gone by when he can justly allow an infection to become deeply ingrained before adopting those tardy, incomplete and often ineffective methods with which he has been too long content.

What is the history of patients in whose lungs projectiles are retained? Our knowledge does not allow us as yet to answer this question fully. But a certain experience is not likely to be changed by a larger survey of cases. We may say with confidence that a rifle bullet, or a small piece of shell casing, may be retained for months or years without causing distress and without affecting appreciably the normal functions of the lung in which it lies buried. But with large or irregular pieces of shell the case is different. I have seen many patients suffering for twelve or eighteen months from cough, with hæmoptysis at intervals. In two cases the loss of blood was serious. And in many patients there is an increasing complaint of pain, dyspnœa on exertion, and of expectoration of mucus.

For these reasons I have recently given special attention to these patients and have submitted a number of them to operation. The results so far entitle me to say that it is probably a safer, as it is certainly a speedier, procedure to submit all patients, in whose lungs a large projectile is retained, to operation rather than to leave them untreated. In almost every case operated upon the projectile has been dropped at once into a culture medium: with one exception all missiles were infected; the organisms most commonly found were staphylococci.

The following are the details of the procedure adopted for the extraction of bullets from the lung. The new features in the method are chiefly due to the initiative and the superb technical skill of Pierre Duval to whom I most gratefully acknowledge my indebtedness. The operation is performed in anæsthesia induced by ether and oxygen. A preliminary injection of morphine and atropine is given about half an hour before the operation.

The patient lies flat on his back, with the arms to the side. A curved incision about 5 or 6 inches in length is made exactly along the line of the fourth rib. The fibers of the pectoralis major are split, and the pectoralis minor separated from the rib. There are many points of hæmorrhage requiring a clip or a ligature. All must be carefully secured so that there is a perfectly dry field. The rib and the costal cartilage are exposed for a distance of not less than 5 inches. An incision is made through the periosteum midway between the upper and lower borders and this membrane is stripped from the rib on both surfaces. A Doyen's curved raspatory is very useful for the purpose. In my earlier operations I cut through the costal cartilage and then divided the rib with forceps so that a

length of 4 to 5 inches of the rib could be removed. In later operations I have freed the inner end of the rib after division of the cartilage, have passed a strip of gauze beneath it, and pulled it upward and outward. In this way the rib may be saved, and replaced at the end of the operation. This, however, is not a point of great importance, for when the periosteum is left, a new rib is formed very rapidly, and the chest wall soon becomes as firm as ever. Care is taken in excising the rib and in lifting it away not to wound the pleura, which must be separated widely from the ribs above and below, to the inner and the outer side of the wound. Unless this is done, accurate closure of the pleura later on, always difficult, will be impossible. A retractor is now placed in the wound to widen the interval between the ribs above and below. Any abdominal retractor will do: but the best instrument I have used is that invented for this special purpose by Tuffier. As wide a gap as possible is made, so that the whole hand can easily be passed into the chest.

The pleura is now incised along the line of the rib and air enters freely and at once into the pleural cavity. As a rule this causes no disturbance and does not alter the rate of the respirations or of the pulse.

The hand is now passed into the chest cavity. Adhesions of the lung to the parietal pleura may be encountered. These are sometimes very slender and easily broken through. At times they are tough and strong and are with great difficulty severed. If they are numerous or thick and tough, bleeding may occur quite freely for a minute or two. With gentle pressure from a hot moist swab, the oozing is soon checked. In a case where a projectile was in the base of the right lung posteriorly, the whole of the lower lobe and a great part of the upper lobe were most intimately adherent to the parietal pleura. The adhesions, however, separated in just the same way as adhesions within the abdomen separate, by gentle pressure and stripping. Thoracic adhesions bleed I think far more freely than those encountered in the abdomen. When all are loosened, the collapsed lung lies free within the pleural cavity. It may now be seized with the fingers or with a special light form of clip and drawn up to the anterior wound, and, little by little, be coaxed out of the wound. It is surrounded as it appears by warm cloths soaked in normal saline solution. When a lobe of the lung is freely delivered it is palpated from top to bottom. Any projectile embedded in it is felt as a rule at once. Even little sequestra blown in from a rib may be recognized without any difficulty. These foreign bodies are as easily recognized as the particles of gritty sand in a new sponge. When the projectile is felt, the part of the lung containing it is made prominent, the lung tissue lying over it is incised, the metal removed, and the wound sutured. Deep stitches of catgut are passed through the lung substance, and with gentle tension act as a hæmostatic.

If necessary very fine catgut sutures may be used to secure the accurate apposition of the pleural edges. If there is any bleeding from the collapsed lung, it is slight and easily controlled, but precision in suture is most desirable, for expansion of the lung will rapidly be secured when the operation is completed. If there are two or more particles of shrapnel or shell casing in the lung, they are all dealt with in the same way. I have once incised the hilum of the lung and stitched it up without difficulty. When the sutures are completed the lung is replaced, the cavity of the pleura most carefully dried and emptied and a gauze swab wet with ether wiped over the visceral pleura, and over any adhesions which may have been separated. The retractor is removed and the parietal pleura now stitched up. This is quite the most difficult part of the operation, indeed I have not been able to close the pleura accurately unless this membrane has been stripped up freely from the chest wall before being incised. The rib, if it has been turned back, is replaced, and fixed in position by a suture through the costal cartilage. The muscles are carefully sutured and the wound edges accurately approximated without drainage. The closure of the wound should be so carefully done as to seal the chest hermetically. When the dressing is applied, a two-way needle may be plunged into the chest, and the ether and air extracted therefrom. The lung then rapidly expands and

faint breath sounds are heard at once. No shock follows this operation.

CONCLUSIONS

The following general conclusions may be stated:

1. The approximate mortality from gunshot wounds of the chest at all parts of the line of communication is 20 per cent.

2. The causes of death are hæmorrhage as a rule within 28 hours; and sepsis after the third or fourth day.

3. The local conditions in wounds of the chest wall and lung are in all respects similar to those met with in wounds elsewhere. The missiles are the same, their destructive effects upon the tissues are the same, and the infecting organisms are the same.

4. The lung tissue is more resistant to attack than many other tissues. The opening of the pleural cavity and the resulting exposure of a large serous sac to infection and all its consequences add, however, a danger of the most threatening character.

5. The chief essential in the treatment of all cases of penetrating wounds of the chest is rest.

6. In clean perforating wounds of the chest, rest together with the cleansing and dressing of the wound of entrance or exit, will lead to the recovery of the great majority of cases.

7. In cases of "open thorax," the earliest and most complete effort possible must be made to secure closure of the wound after an appropriate toilet.

8. In those rare cases of grave hæmorrhage, when hæmoptysis is present or when the blood escapes by the wound, a direct access to the source of the bleeding must be obtained, when all contingent circumstances permit, and the wound in the lung must be treated by suture, preferably; or by plugging of the cavity from which the blood escapes.

9. In cases of hæmothorax when the blood effused is small in quantity and remains sterile, no active measures are necessary, unless absorption is long delayed. Aspiration, repeated if necessary, may then be performed.

10. In cases of hemothorax, when the blood effused is large in amount and remains sterile, aspiration after the seventh or eighth day, or earlier in cases of urgent dyspnœa, certainly hastens convalescence, permits a more rapid expansion of the lung, and prevents the formation of firm adhesions which may permanently cripple the free movements of the lung.

11. In cases of hæmothorax, whether the amount of blood is small or large, when infection takes place, open operation is necessary. Early operation both when the Carrel-Dakin technique or Morison method are adopted saves many weeks of convalescence and permits of a more perfect functional recovery.

12. Small foreign bodies, or rifle bullets, imbedded in the lung, often cause no symptoms; they become encapsulated and may safely be left.

13. Larger foreign bodies retained in the lung may cause distressing or disabling symptoms for long periods. In such cases removal after resection or elevation of the fourth rib through an anterior incision will allow of the safe removal of the projectile from any part of the lung. Pieces of metal so removed are almost always infected.

SODIUM PERSULPHATE IN THE TREATMENT OF TETANUS

By DR. L. LEYVA, Bogota, Columbia

ANTITETANIC serum beyond a doubt has produced marvelous results, but it does not always prevent tetanus; and we who have worked in military hospitals have seen not a few cases which have been treated by means of tetanus bacillus injections, with results which were almost invariably fatal.

Before the introduction of sodium persulphate in the American Hospital in Paris, 75 per cent of the cases of tetanus ended fatally, notwithstanding the fact that the hospital staff was excellent and there was at hand every requisite to carry out the most complicated technique.

It is true that the number of cases treated with persulphate of sodium is not large enough to establish its efficiency beyond question; on the other hand, it is quite possible that the fact that the patients who were treated in this way recovered, while the others did not, is not due to pure chance.

These considerations impel me to publish the particulars of three cases which have been so treated, and which I append hereto. Later, when I have had the opportunity of observing more cases, I intend to write a more lengthy article on the subject; today I am content with presenting a few particulars, so that my colleagues may know of the efficacy of sodium persulphate in the treatment of tetanus.

It is a fact that persulphate, combined with the antitetanic serum, relieves the pains and spasmodic attacks to such an extent that the patient begs to be given the injections.

The minimum dose must be 60 cubic centimeters in one day, as was clearly proved by the third case, in which there was no improvement until this dose was reached.

The solution must be freshly prepared, and must be kept cold and in a shaded place, as both heat and light decompose it. In the American Ambulance Hospital the injection was prepared in doubly distilled water, using the persulphate of sodium in sealed bottles prepared by the firm Lumière, of Paris.

Case 1. Paul C., 35th Regiment of Infantry (French Army): age 20. Wounded on March 1, 1916, in the head, right arm, and right thigh, by the explosion of a shell. An injection of antitetanic serum was given at the first dressing, and a second injection on the following day.

March 17, admitted to the American Ambulance, Paris. *Symptoms:* three wounds in the head: one in the left parieto-occipital region that exposed the bone; one in the frontal region, and another in the right parietal region. The ring and middle fingers were amputated, the flaps of the stumps were septic and gangrenous.

There was a compound septic fracture at the lower third of the right femur; the wound was about 50 centimeters long and situated in the internal aspect of the thigh and had several drainage tubes which emerged through a counter opening in the postero-internal surface of the limb.

March 18, operation by Dr. Mignot. The site of the fracture was explored, and various loose splinters of bone were removed. This operation was performed for the purpose of removing the foreign bodies shown by the X-rays and to alter the position of drainage. No foreign body could be detected by means of the electrovibrator of Bergogne from Bordeaux. A counter opening was made in the postero-inferior aspect of the thigh. Carrel drainage was established and the wound was irrigated every two hours with Dakin's solution.

March 28. Acute irritation of the skin, due to the Dakin's solution, made necessary the discontinuation of this treatment, and the wound was irrigated with hot saline.

April 3 and 4. Yodargol dressings.

April 5. In the course of the afternoon the patient experienced difficulty in opening his mouth and complained of headache and pain in the neck.

April 6. Tetanus was diagnosed. First injection of antitetanic serum fifteen thousand units preceded by an intravenous injection of two thousand units of the same serum to guard against the anaphylaxia.

April 7. Three intravenous injections of 20 cubic centimeters each of antitetanic serum were given. The patient became worse. Trismus became complete and the spasmodic contractions of the muscles of the neck and shoulder were more frequent and stronger, spasmodic contractions of the diaphragm were extremely distressing owing to embarrassment in respiration.

Dr. Mignot advised Lumière's treatment of intravenous injections of sodium persulphate; dose 20

cubic centimeters of a 5 per cent solution freshly prepared. First injection at 2 p.m. given very slowly (five minutes were taken in injecting the liquid). After the injection the patient had nausea and vomiting for half an hour but the respiration became easier. Second injection at 9 p.m. accompanied by a subcutaneous injection of 10 cubic centimeters antitetanic serum; the same symptoms were produced.

April 8. Diaphragmatic contractions seemed to be less intense, otherwise general conditions similar to previous day. The muscular contractions displaced the fragments of the fractured femur and produced attacks of excruciating pain. Three injections of sodium persulphate were given at 8 a.m., 2 p.m., and 9 p.m., respectively. Notwithstanding the nausea that followed, the patient himself begged for the injection and said that it alleviated the pain and allowed him to sleep.

April 9. Intravenous injections of sodium persulphate were given: one in the morning, and one in the evening, also two subcutaneous injections of 10 cubic centimeters antitetanic serum. The temperature rose to 101.5° F.

April 10. Only two injections were given, the patient being much better.

April 11. Two injections of sodium persulphate.

April 12. Symptoms of bronchopneumonia with marked physical signs at the base of the left lung. The pneumonic symptoms and signs subsided in three days; during this period only one injection of sodium persulphate was given daily as the cough seemed to be worse after the injections.

April 15. Patient had a better day. The spasms were less frequent and the trismus was commencing to yield. Two injections of sodium persulphate were given at 9 a.m. and 3:30 p.m. respectively.

April 16. One injection of sodium persulphate and one of antitetanic serum. Temperature rose to 102.2° F. and the muscular contraction of the thigh became more frequent than in the previous day. Three injections of sodium persulphate and three antitetanic serum. The third injection was followed by a reaction characterized by vomiting and malaise.

April 17. Two injections of sodium persulphate and antitetanic serum at 9 a.m. and 2 p.m.

April 18. Same treatment at 11 a.m. and 7 p.m.

April 19. One injection at 9:30 a.m.

April 20. One injection at 9:30 a.m.

April 21. One injection at 9:30 a.m. The injection of sodium persulphate and antitetanic were given simultaneously. The symptoms and signs of tetanus disappeared and the general condition of the patient was greatly improved, but a patch of bronchial pneumonia was detected in the left lung, this was successfully treated by dry cupping and subcutaneous injections of gomenol oil.

The patient was removed from the isolation of a general ward. Extension was reapplied to correct the displacement of the segments of the fracture caused by the muscular spasms. The patient was free from symptoms of tetanus until July 14.

July 15. Headache. Beginning of trismus. Patient said he experienced similar sufferings to those that he had had at commencement of attack of tetanus. Antitetanic injections were immediately given. The same process to ascertain the presence of anaphylaxia was employed.

July 16. Two injections of sodium persulphate with one of antitetanic serum.

July 17. Two injections of sodium persulphate with one of antitetanic serum.

July 18. Two injections of sodium persulphate with one antitetanic serum.

July 19. Two injections of sodium persulphate with one of antitetanic serum.

July 20. Two injections of sodium persulphate with one of antitetanic serum.

July 21. Two injections of sodium persulphate with one of antitetanic serum. Patient better.

July 22 and 23. One injection of sodium persulphate and one of antitetanic serum.

July 25. Patient cured. This second attack had not been so severe as the first one.

August 18. Operation by Dr. Mignot. On reopening the wound the femur was found stripped of periosteum for a length of 4 centimeters. Three large sequestra were removed. Drainage tube in the posterior aspect of the thigh. The wound was treated with Dakin's solution until September 20. September 22, operation by Dr. Leyva.

Two prophylatic injections of antitetanic serum. A longitudinal incision 10 centimeters in length was made in the anterior surface of the right thigh. The bone was exposed and a round sequestrum 6 centimeters long was removed. The wound was plugged with iodoform gauze. On attempting to remove the knee-joint the femur was refractured. An extension was applied the same day and the bone re-united in better position.

The patient left the hospital December 15. The right knee was ankylosed but the fracture of the femur had united in good position. There was one centimeter shortening. The wounds of the head and hand were perfectly healed.

CASE 2. Lucien C., 2nd Regiment *Chausseur a pied*, age 23. Wounded on November 16, 1916, by the explosion of a shell. Dressed at the clearing station and operated on at a base hospital for extraction of shrapnel. Also an injection of antitetanic serum was given.

On admission to American Ambulance, Paris, the patient had several septic wounds: one on the dorsum of the left hand, one on the middle third of the left leg, a superficial one in the middle third of the right leg, another superficial wound just above the articulation of the right knee, a compound fracture of the third metacarpal bone, and finally, a suppurating wound which involved the right shoulder-joint.

The roentgenogram showed a small piece of shrapnel in the left hand and confirmed the fracture

of the third metacarpal; it also demonstrated the presence of another piece of shrapnel near the head of the right humerus, also in the lower third of the left leg and in the upper third of the right leg.

November 27. Shrapnel was extracted by Dr. Johnson.

December 2. The patient complained of acute pain in the left leg. In the evening there were symptoms of tetanus. The temperature remained normal (the pains resembled lightning pains).

December 3. The treatment with sodium persulphate was begun. As the case was not a severe one, only one daily injection was given up to 12. The patient experienced only slight relief after the injection, but there was no alteration in the symptoms until December 11, when the temperature rose for the first time to 100.2° F. As it was considered that one daily injection was not sufficient, two were given. Two days later the muscular contractions were less frequent and the pain much less intense.

December 14. Tetanic contractions and pain had almost disappeared, and the treatment was continued until December 16. From this date all medications stopped. The flexors of the thigh became permanently contracted, and the leg remained in a position of complete flexion.

CASE 3. Henri F., Regiment 329 Infantry, age 32. Wounded by a bullet July 5, 1916. First dressing at a clearing station where an injection of antitetanic serum was given four hours after injury. The patient was treated during the following eleven days at a base hospital where he was operated on for extraction of spicules of bone. Drainage of the wound was established. Admitted to the American Ambulance Hospital of Paris on July 18.

On admission, the general condition of patient was satisfactory. A large wound extending from the right corocoid process to the middle of the spine of the right scapula. The pectoralis major muscle was divided and the glenoid cavity could be seen at the bottom of the wound. The head and the upper fourth of the humerus had been blown away. The wound was drained by two large tubes which passed from the anterior part of the arm to a counter opening in the postero-internal aspect. There was no injury of any nerve. The wound was perfectly clean.

July 19. The roentgenogram demonstrated a fracture of the humerus and the absence of the head and surgical neck of the same.

Treatment by Carrel's method was started.

July 20, 21, and 22. Normal improvement; suppuration less; temperature normal.

August 1. The improvement continued until the evening of this day when the patient complained of sharp pain in the arm; but it was not until August 3, that muscular contractions accompanied the pain. Some trismus was present and palpation of the neck revealed contraction of the sternocleidomastoid, and later some limitation of extension. At the same time the temperature rose to 102° F. The diagnosis of tetanus was established and at 6 p.m., and injection of 10 cubic centimeters of antitetanic serum was given, preceded by an intravenous injection of one thousand units of the serum to ascertain the presence of anaphylaxia. At 7 p.m. 20 cubic centimeters sodium persulphate 5 per cent solution was given. At 10 p.m. injection was repeated, accompanied by another injection of 10 cubic centimeters antitetanic serum.

August 5. The patient's condition became worse. The trismus and rigidity of the neck became more pronounced; both pain and muscular contractions of the arm were more frequent. At 9 a.m. 10 cubic centimeters of sodium persulphate and 20 cubic centimeters of antitetanic serum were administered. At 2 p.m. these were repeated, and also at 10 p.m.

August 6. The tetanus began to subside; the muscular contractions were weaker and less frequent. The strongest took place at the moment of the injections which were given in the same doses as in the preceding day. Temperature lower.

August 7 and 8. Same treatment.

August 9. The temperature subsided. The patient was able to open his mouth from one to two centimeters.

August 10, 11, and 12. The same treatment. Improvement continued; less pain and the mouth could be opened more easily.

August 20. Improvement became more marked; only 2 injections of sodium persulphate and one of antitetanic serum were given.

August 21. The cure was almost complete. One injection of sodium persulphate.

August 23. The patient was transferred from the isolation to a general ward. The healing of the wound was steadily progressing and was still treated with Dakin's solution.

September 28. The patient was discharged in good condition. The wound was nearly closed (there was no union of the fracture). There was a pseudo-arthrosis of the humerus.

A STUDY OF THE RECTOSIGMOID[1]

By WILLIAM J. MAYO, M.D., Rochester, Minnesota

THE rectosigmoid, the narrowest part of the large intestine, consists of 3.5 inches of the intestinal tract which includes the terminal 2 inches of the sigmoid and the proximal 1.5 inches of the rectum. It is a definite mechanism which retards the fæcal current and prevents continuous progress of the intestinal contents into the rectum. The examination of a large number of men for army service demonstrates that in the adult the normal rectum does not retain fæces for any length of time, and when it does, such action is artificial and pathologic. With the exception of the pyloric end of the stomach and the first portion of the duodenum, the rectosigmoid is more frequently diseased than any corresponding portion of the gastro-intestinal tract.

In the older anatomies, the terminal 2 inches of the sigmoid was often, if not usually, called the first portion of the rectum because of certain anatomic peculiarities which rendered it difficult to say with certainty whether it was sigmoid or rectum. Following the researches of Treves and Jonnesco, it was definitely concluded that this portion of the intestinal tract was a part of the sigmoid and it is so designated in all of our later anatomies. The rectum proper begins at the middle of the third sacral vertebra and, anatomically speaking, ends at the level of the apex of the prostate in the male and at the upper level of the perineal body in the female, sites which mark the beginning of the so-called second portion of the rectum, or more correctly, the anal canal.

The anal canal of Symington has its origin in the proctodeum or skin infold. It is lined with pavement epithelium, has no mucous glands, and is in no way a part of the rectum, but is rather a retentive mechanism extraordinarily well adapted to temporary rectal retention. The anal canal is about 3 centimeters in length, and passes upward and forward at such an angle in relation to the musculature of the rectum as to relieve the strain on the sphincter muscles. This valve type of mechanism is exhibited in the compression of the ureter in the wall of the bladder and of the common duct in the wall of the duodenum. Its most important artificial imitation is shown in the brilliant work of Coffey which has made transplantation of the ureters to the large intestine an operation of safety and precision.

The rectum is, therefore, a single organ averaging 11 centimeters in length, with a protective sigmoid mechanism above and the sphincter apparatus of the anal canal below. The upper of the two left valves of Houston, which is nearly always discernible although sometimes rudimentary, lies just below the inferior margin of the terminal sigmoid constriction. The lower left valve of Houston lies below the level of the peritoneum, while the single large right valve, which is nearly always present, projects well across the lumen of the rectum near the mid-point.

The ampulla of the rectum may be described as the sacculated portion lying between the anal canal and the lower left valve of Houston. The middle portion of the rectum ends above at the right valve, while the upper rectum extends to the sigmoid at the upper left valve. The index finger of the average examining hand, when the anal canal is forcibly elevated, can reach to, and often a little above, the right valve of Houston, but not to the rectosigmoid juncture (Fig. 1).

This interpretation of the anatomy of the rectum is in harmony with its embryologic origin. The rectum proper is derived from the cloaca, a highly differentiated part of the hind gut from which also the bladder is derived. Definite anatomic changes are to be found in the epithelial layers of the mucous membrane at the rectosigmoid juncture and possibly a tissue weakness worthy of note.

The terminal 2 inches of the sigmoid

[1] Presented before the American Surgical Association, Boston, June 1, 1917.

(Fig. 1) has considerable resemblance to the lower rectum just above the anal canal. The more or less circular folds of the mucous membrane of the sigmoid here take on a longitudinal arrangement with much the appearance of the columns of Morgagni and the rectal sinuses, and end in a rudimentary sphincter apparatus at the very beginning of the rectum. This hint of a sigmoid sphincter at the rectosigmoid union forms a well-marked resisting constriction to the readily dilatable sigmoid above and the rectum below (Jonnesco, Markel).

Examination shows that this circular band at the termination of the sigmoid contains considerable non-striated muscle fiber (Figs. 1 and 2). Clinically, there is often seen through the proctoscope, when the patient strains during examination, a tendency of the movable sigmoid to project through this muscle band as a slight intussusception into the fixed rectum. Tumors in the terminal sigmoid are not infrequently intussuscepted into the rectum, giving the diagnostician on digital examination the erroneous impression that they are rectal.

Through the kindness and with the aid of Dr. C. M. Jackson, head of the Department of Anatomy, University of Minnesota, Dr. T. B. Reeves, at my request, carefully dissected the rectum in forty-six cadavers. The terminal sigmoid constriction (Figs. 1 and 2) was found in 80 per cent, and in two of the forty-six it amounted to a definite narrowing which reduced the caliber of the rectosigmoid juncture to a considerable extent. This narrowing seems to have attracted little attention from surgeons, and in the large majority of cases it is so slight as to be readily overlooked (Fig. 1). In addition, the anatomy was very carefully worked out in the cases presented for operation and the drawings are the result of these combined studies.

Examination of the rectosigmoid, that is, the part of the rectum which lies above the right valve of Houston and the terminal 2 inches of the sigmoid from the inside shows not only those definite changes in color and arrangement of the mucous membrane which characterize the rectum and sigmoid re-

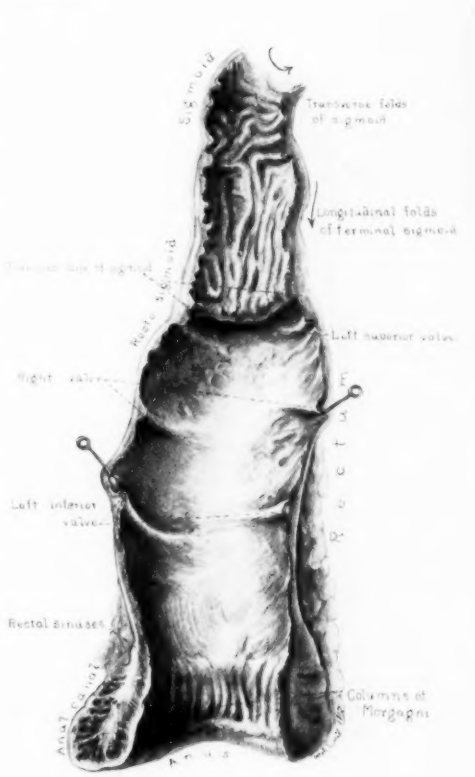


Fig. 1. Terminal sigmoid, rectum, and anal canal from inside.

spectively, but also in a high percentage of subjects the rudiments of the terminal sigmoid sphincter which defines the two organs. Examination of the outside of the rectosigmoid discloses prominent features of identification: (1) The rectum has no mesentery; (2) the longitudinal muscle bands of the sigmoid spread out, making a complete longitudinal layer for the rectum; (3) the superior rectal artery divides into the right and left branches at the origin of the rectum; and (4) the absence of epiploic tags, which are found on the sigmoid to its end (Fig. 2).

The impression is gained that ordinarily the rectosigmoid is an arrangement for re-

Fig. 2. Terminal sigmoid, rectum and anal canal seen from behind, with relation to bony pelvis.

tention of contents in the sigmoid proper, and that under certain circumstances the controlling mechanism may subject the parts to undue stress.

The rectosigmoid apparatus is controlled by the pelvic plexus of nerves which is made up of a variable number of sympathetic ganglia joined from above by spinal nerves from the lumbar region and from below by spinal nerves from the sacral region. From the lower part of the pelvic plexus nerves can be traced into the rectosigmoid region and the rectum. The inferior mesenteric plexus, containing a variable number of sympathetic ganglia, follows along the course of the superior hæmorrhoidal artery and helps to supply the rectosigmoid and the upper part of the rectum. According to Langley and others, the nerves derived through the hypogastric plexus are inhibitory in action, while those from the spinal and sacral nerves are motor (Fig. 4).

In addition to the nerves mentioned, the smooth muscle fibers which compose the musculature of the rectosigmoid, like all non-striated muscle fibers, have the power of originating contraction and, according to Keith, these impulses are collected in certain neuromuscular nodes and correlated. Failure of co-ordination results in a most curious and interesting pathologic phenomenon: the so-called idiopathic dilatation of the colon, or Hirschsprung's disease. A number of cases of this condition have been recognized since the attention of American surgeons was called to it by Finney. The disease is similar in origin to cardiospasm at the cardiac orifice, pylorospasm, and stasis at the ileocæcal valve.

The terminal sigmoid, as held by its men-

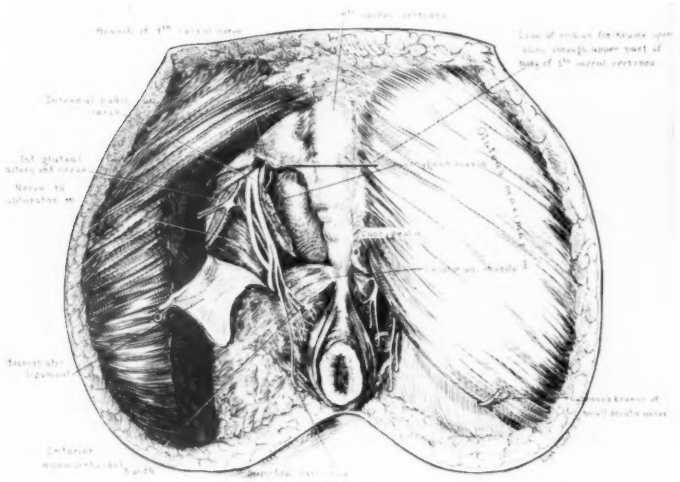


Fig. 3. The superficial anatomy of the sacral, coccygeal, and anal region. Note the notch which marks the line of bone section just below the fifth sacral foramina.

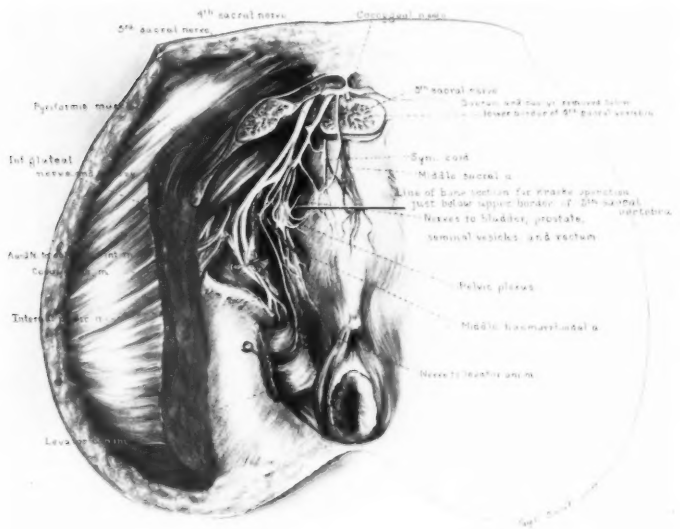


Fig. 4. The deeper anatomy of the region shown in Fig. 3 as exposed by section through the third sacral vertebra as first advised for the Kraske operation. This line of section is liable to produce extensive injuries to important nerves and predisposes to sacral hernia. Line of section through the fifth sacral vertebra gives sufficient exposure and no important nerves are injured.

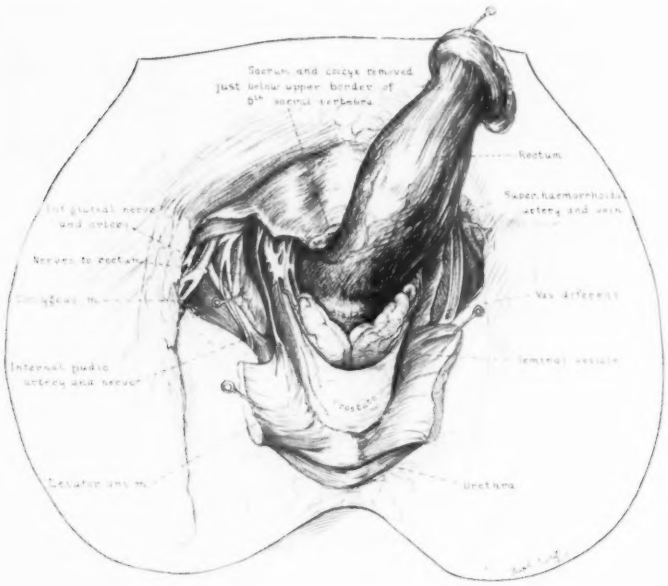

Sacrum and coccyx removed just below upper border of 1st sacral vertebra
Rectum
Sup. haemorrhoidal artery and vein
Vas deferens
Internal pudic artery and nerve
Urethra

Fig. 5. Anatomy anterior to rectum in the male as seen in Kraske operation.

entery, has considerable play, and it curves from its rectal attachment. The longitudinal muscle bands are well developed and by spreading out grasp the entire rectum. It is probable that contraction of these bands from the fixed point of the rectum under proper stimulation enables the sigmoid to straighten and pour its contents into the rectum, while under ordinary circumstances the angulation is co-effective in retention. Investigation shows that the emptying of the large intestine from the splenic flexure is accomplished largely by syphonage. The hardened head of the fæcal current rests at the rectosigmoid and the syphon is established when this mass, which can be compared to the piston of a syringe, moves onward.

From the foregoing it may be seen that the rectosigmoid is a distinct anatomic region which possesses some of the characteristics of the pylorus and of the ileocæcal mechanism, and that it depends on its anatomic arrangement for function. The difficulty of guiding tubes and instruments from the rectum into the sigmoid is due to the rectosigmoid mechanism and makes futile the use of the so-called colonic tube in which the passage of a length of tube out of sight into the rectum where it remains coiled leads to the supposition that it has passed into the sigmoid. Single or several polypi which are so frequently found in the ampulla of the rectum and which, on straining, are grasped in the sphincter apparatus and rendered pedunculated, have their counterpart in the single, or at most, two or three polypi, which are so often found in the terminal sigmoid and which for the same reasons have become pedunculated into the rectum.

Experienced observers have called attention to the frequency of infections, polypi, diverticula, and various other pathologic conditions in the terminal sigmoid. With the exception of the pyloric end of the stomach, carcinoma is to be found more frequently in this 3.5 inches than in any corresponding part of the gastro-intestinal tract. In an investigation of the last 100 specimens of cancer of the rectum and rectosigmoid removed consecutively at St. Mary's

hospital, Rochester, Minnesota, it was found that 28 were located in the rectosigmoid juncture, extending as much onto the rectal as onto the sigmoid side, 21 involved the juncture but extended more onto the rectal than onto the sigmoid side, 14 involved the juncture but extended more onto the sigmoid than onto the rectal side. Thus 63 per cent involved the rectosigmoid, 30 per cent the rectum only, and 7 per cent the anal canal.

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POSTOPERATIVE PULMONARY COMPLICATIONS[1]

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INTRODUCTION

THERE is a somewhat smug satisfaction and comfort to the surgeon in the phrase "unavoidable surgical calamity." Under this heading, surgeons often feel justified in placing some of the fatalities of surgery, and more especially the postoperative complications of pulmonary embolism, and a certain number of the postoperative pneumonias, commonly known as "ether pneumonias." But for those who have carefully studied and observed such cases and have sifted out all the underlying factors and possibilities which might be considered in their etiology, this phrase loses in its persuasiveness. In a majority of instances, thorough analysis reveals factors that remove the case from any class labeled "unavoidable calamities," and we have found that the general condition of the patient, the presence of sepsis or pre-existing lung pathology or unjustifiably long or radical operation was often sufficient to explain any subsequent untoward result. In the ultimate analysis, poor judgment is more often a tenable expression. Such criticisms sound harsh, but the truth is often brutal, and it is only by thus frequently checking up our own failures that we realize them. Taking our mishaps one by one, they are soon forgotten, and we may be led to believe that our results are better than they appear in cold figures.

This study was undertaken at the suggestion of Dr. Porter and Dr. Scudder, chiefs of the two surgical divisions of this hospital, because of the occurrence of a large number of postoperative pulmonary complications, during a rather short period of time. We have taken the cases operated upon during the year July 1915 to July 1916 at the Massachusetts General Hospital. During this period, there were 3,490 operations, which include the major operations of the Throat, Genito-Urinary and Orthopedic Departments, as well as the work of the General Surgical Services. Thus, our study embraces the most varied and general class of patients and operations. The majority of the patients are from the city, and we cannot boast that their average well-being is such as to offer good surgical risks, but with the addition of the few patients that come in from the neighboring country the average is brought up to at least an ordinary safe risk. We make

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this point of discussing the wide general field both as to operation and type of patient, since it is only by a true realization of these factors that any honest comparison can be made with the many reports on postoperative complications from other clinics.[1]

In our analysis we have studied the records critically with especial reference to the pre-operative condition, more particularly pulmonary, to the general course, amount and type of anæsthesia, and to the postoperative course of the cases. We have included all postoperative cases developing lung complications, and our problem has been to try to bring forward some of the causes, or at least the contributing factors of these complications. Terminal lung conditions, as in general sepsis, we have not included since the pulmonary trouble is merely a side issue. Also we have excluded the lung complications of lung abscess operations, and operations for empyema because of the certainty of further pulmonary involvement in every instance. We have been particularly anxious to keep the problem broad and not to confine it to a study of the anæsthesia risk alone, or to the pneumonias alone, or to the risk in any given field of operation.

Very few papers have discussed the subject from the aspect of postoperative pulmonary complications as a whole, and more often it is presented as a study of a single pathological entity as "ether pneumonia" or "pulmonary embolism," or a study of the lung complications following a definite type of operation, or in a limited field, and is not a summary of the incidence of such sequelæ in the entire realm of surgery. Therefore, such a review as ours, because of the diversity of its scope, may not seem to point so sharply the dangers of operation in any given field, but we feel that it serves a valuable purpose in calling strongly to attention the very certain risks involved by any operation, and more especially the added dangers in a few anatomical regions and with certain types of patients.

We are particularly anxious to point out that a careful study of the pre-operative risk as shown by already existing lung pathology, old age, general debility, and poor circulation will reveal sources of what may often result in fatal postoperative complications. Thus it is really the judgment of surgeons as to the pre-operative general risk that we hope chiefly to bring under fire. This criticism naturally does not apply to the few urgent surgical conditions demanding immediate interference. In addition, our statistics add to the mass of evidence which demonstrates the high incidence of postoperative pneumonia and the greater proportional occurrence of lung complications in operations in the upper abdomen and upon the face and neck.

We would refrain from discussing methods of anæsthesia, were it not that many consider that postoperative pulmonary complications are to a great extent dependent on this factor. Anæsthesia in this hospital is given (1) by nurses who are specially trained and chosen to do this work only, and whose experience is considerable, and (2) by the junior house officers. On rare occasions a professional anæsthetist takes over a case. The work as a whole is fair, certainly up to the average, but not above criticism. Mallinkrodt's ether is in routine use.

The semi-open cone method of giving ether is used for straight ether, the Bennett inhaler followed by the cone for the gas and ether sequence, and the Ohio monovalve apparatus (Crile) for the gas and oxygen, or gas, oxygen and ether anæsthesias. Anæsthol is dropped on an open mask. As a rule, morphia grains 1/6 and atropine grains 1/120 are administered about one-half hour before operation. Other than the customary toothbrush and a simple cleansing alkaline mouth wash (modified Seiler's mixture) no especial effort is made to establish oral asepsis except in the gastric cases and those having operations about the mouth. In these two groups it is the rule to have a thorough investigation and prophylactic treatment by a dentist. The field of operation is shaved, cleansed, and covered by a sterile dressing the evening before operation. Laxatives the day before, and an enema the morning of the operation are given to ensure an empty bowel.

In our series of 65 postoperative pulmonary complications in 3490 cases, the kind of

[1] See Section 4.

anæsthesia used and the resulting postoperative lung complication with the different anæsthetics are shown in the accompanying table.

POSTOPERATIVE COMPLICATIONS FOLLOWING DIFFERENT ANÆSTHETICS

	Straight Ether	Gas and Ether	Gas, Oxygen, Ether, Local	Gas and Oxygen	Anæsthol	Local (Novocaine, Cocaine Etc.)	Ether Anæsthol	Totals
Lobar pneumonia	11	4	2	1	..	..	1	19
Bronchopneumonia	12	3	..	1	1 (spinal also)	3	1	21
Bronchitis	5	2	..	..	..	..	..	7
Pleurisy	3	1	..	1	..	..	..	5
Empyema	1	..	..	1	..	..	..	2
Pneumothorax	1	..	1	..	..	..	..	2
Mediastinitis	1	1	..	..	..	1	..	3
Pulmonary embolism	3	1	..	..	1	..	..	6
Lung abscess	..	..	..	..	..	..	..	0
Totals	37	12	4	4	2	4	2	65

The above classification into types of pulmonary disease is arbitrary and in order not to count single cases twice, when a patient had two or more complications, we have recorded such cases under the pathological entity which we have felt was chiefly at fault.

The greatest difficulty we have found to be that of classification. In the great numbers of studies of this subject, especially in the German reports, there is the widest variation as to the method of classification. The subject may be divided into (1) pathological types (pneumonia, pleurisy, etc.); may be arranged (2) according to the time incidence (late or early); studied (3) in relation to the method or kind of anæsthesia; classified (4) as to the method of infection (embolic, aspiration, or irritative); or (5) analyzed according to the pathways of infection (air passages, blood stream, lymphatics).

PRESENTATION OF MATERIAL WITH POSTOPERATIVE PULMONARY COMPLICATIONS

Our analysis covers 3490 cases operated upon during the year July 1915 to July 1916. In this number 65 cases presented definite postoperative pulmonary complications. We feel that in addition several cases with a mild bronchitis or a transient pleurisy escaped classification in the hospital records through not being sufficiently recorded in the postoperative notes. Both of us personally remember such instances and others must have escaped our notice. None of the fatalities, however, can be included in this number so that the percentages are not appreciably altered by their absence.

Considered broadly as pathological types the pulmonary complications fall into the following clinical groups: pneumonia, lobar and broncho; bronchitis; pleurisy; empyema; mediastinitis; pulmonary embolism; pneumothorax; and lung abscess.

We have classified our material under these main headings and will review the groups individually and try further to subdivide them according to time of onset after operation, pathway of infection, anæsthetic employed, etc. The absence of necessary data and of sharply defined lines renders any classification imperfect and admittedly arbitary. The occurrence of pulmonary complications with morbidity and mortality percentages is shown in the accompanying table.

PULMONARY COMPLICATIONS

Complications	Number of Cases	Morbidity Per Cent	Number of Deaths	Mortality Per Cent of Morbidity	Approximate Morbidity per 100 Cases	Approximate Mortality per 100 Cases
Pneumonia						
Lobar	19	0.54	11	57.9	1 in 183	1 in 317
Broncho	21	0.60	11	52.4	1 in 166	1 in 317
Bronchitis	7	0.20	0	00.0	1 in 497	0
Pleurisy	5	0.14	1	20.0	1 in 697	1 in 3490
Empyema	2	0.05	1	50.0	1 in 1745	1 in 3490
Mediastinitis	3	0.08	3	100.0	1 in 1163	1 in 1163
Pulmonary embolism	6	0.17	6	100.0	1 in 582	1 in 582
Pneumothorax	2	0.05	0	00.0	1 in 1745	0
Lung abscess	0	0.00	0	00.0	0	0
Totals	65	1.8	33	50.7	1 in 54	1 in 106

Lobar pneumonia. The majority of postoperative pulmonary complications fall into the pneumonia group with the number about equally divided between the lobar and disseminated types. This is to be expected since it is into these classes that fall the complications commonly attributed to the anæsthesia (Lord, 1). The greater proportion of the cases, where irritation from the anæsthetic might be taken as the chief factor (the so-called ether-pneumonia group), fall into the group of lobar pneumonia, while the cases of embolic origin naturally develop broncho-

pneumonia, occasionally of the widely disseminated, septic type. We will undertake to discuss the cases more or less in relation to the time of onset of the pulmonary condition after operation, for we find that when taken in this relation the cases fall naturally into fairly well-defined groups. These groups are constituted as follows: (1) cases with pneumonia already present at entrance, and operated upon through necessity or because of a mistaken diagnosis; (2) cases developing pneumonia within a few hours to three days in which it seems that the condition may be chiefly attributed to the effects of the anæsthesia and which are commonly called the irritative class; (3) a few rare cases in which the postoperative aspiration of gross food particles, blood, or mucus seems at fault; and (4) the cases developing later in the convalescence in which the embolism of bacteria alone, or of small septic plugs seems the most probable source of infection.

In the lobar pneumonia class, there are 19 cases divided as follows: Class I, three cases with pneumonia present when operated upon, Cases 1, 2, and 3; Class II, eleven cases developing pneumonia within four days, i.e., within a period so close to the time of operation that blame, at least in part, may be placed upon the anæsthetic, Cases 4 to 14 inclusive; Class III, one case, 15, pulmonary lesion evidently due to the postoperative aspiration of food particles; and Class IV, four cases in which the pneumonia developed on the fourth day or later, and which careful study has led us to believe have as their etiology emboli from the field operated upon. These are Cases 16 to 19 inclusive.

The separation of the cases into these four main classes is admittedly arbitrary, for no sharp lines can be drawn, but it seemed necessary to make some division to facilitate comparison and study. The group of cases having pneumonia already present at entrance needs no further comment. It is inevitable that in any large series of lung conditions the signs and symptoms of pneumonia may simulate those of cholecystitis as in Case 1, or of appendicitis as in Case 2; and though it is regrettable that a more thorough chest examination was not made in these cases it must be remembered that often the pulmonary signs may be very difficult to appreciate at a time when other symptoms are in the foreground. Case 3 obviously demanded operation.

Into Class II, the irritative type, fall the majority of the lobar pneumonia cases; 11 out of 19. As a group this class is well defined but individual cases in it, as Cases 12 and 14, may appear atypical. This will be true in any classification where the divisions are indifferently made. Case 12 presents the possibility of etiology other than irritative. Here the process was confined apparently to one base and there was considerable purulent sputum. One may justly suspect the flaring up of some unrecognized pre-existing lung condition, possibly a metastasis or a latent bronchiectatic cavity. The presence of râles before operation must not be underestimated, and the short course and fatal termination urge one to suspect the pneumonia was more widespread than diagnosed. Case 14 had a definite pre-operative lung pathology, was an old man and a poor risk, and though no frank signs of pneumonia were present until the fourth day, unquestionably the consolidation began earlier and was merely an extension from the pre-existing condition. The other cases in this class, 4 to 14, exclusive of the two above mentioned, are fairly clear cases of pneumonia setting in soon after operation and most frequently involving both sides. Several of these cases were bad risks but some were the opposite. In no case was there clinically a history of embolism and no particular opportunity for the postoperative aspiration of food, mucus, or other material. These cases seem to constitute a very definite group where the irritation of the anæsthesia is immediately followed by pneumonia. An individual consideration shows that in addition to the irritation of the anæsthetic there was always present, except in Case 10, further contributory factors. In five instances, Cases 7, 9, 12, 13, and 14, there was a definite pre-existing lung pathology; in two instances sepsis without the lung was present, in Case 6 associated with anæmia and in Case 11 with extreme age. Cases 4 and 8 developed considerable shock, and in 5 the possibility of

lung metastases must be considered. Thus in all but a single instance there was superimposed on the irritation of the anæsthesia, additional factors. The single exception, Case 10, is further interesting in that it made a perfect recovery to normal.

Class III is as definite as Class I, for it is self-evident that operations after which food or mucus may be aspirated into the lung will be followed by lung complication in a certain percentage. Case 15 is typical of this group. A resection of the tongue was done with the result that the patient experienced constant difficulty in swallowing. Food, mucus, and liquids were frequently sucked into the lung and a fatal pneumonia resulted. As was expected the lesions were rather disseminated and a purulent bronchitis was present as well as the pneumonia.

Class IV, the embolic group, is more difficult to define. Emboli may come by the lymphatics or by the blood stream, may be large or small, septic or sterile. (Homans, 2). Because of this diversity of type the cases need more individual discussion. Case 16 at once may be labeled a questionable case, for the rapidity of onset, the bilateral involvement, as well as the poor risk tempt one to call it another case of irritative pneumonia. Irritation was a factor in part, but with so much sepsis present before operation, we feel that, though the irritation paved the way, the source of the pneumonia was most probably small emboli, possibly only bacterial (pyæmia) from these foci. In the true irritative type we feel that the organisms infecting are probably those already present in the lung which are merely given an excellent foothold. Case 17, after a fair operative recovery, had an attack of pain in her side followed by pneumonia. While improving from this, she very suddenly died, making us suspicious of a pulmonary embolus. Case 18 ran much the same course but the pneumonia was followed by a septic pleurisy with effusion, which we think is a further argument favoring the embolic nature of the original infection. Case 19 had an uneventful convalescence for 14 days when consolidation of the lower lobe occurred. There had been no exposure or other known factor, yet the lesion was well marked. Hypostasis must be considered but with a freshly healed wound we prefer to attribute the etiology to the setting free of small emboli from the field of operation through bodily activity.

(NOTE.—In the following abstracts of cases we have stated the pre-operative diagnosis, the pre-operative condition only so far as it has possible bearing on the subsequent pulmonary condition, the operation and the postoperative course. Autopsy findings stated when procured.)

CASE 1. E. O'B., female, age 61, May. Diagnosis, cholecystitis; suspicions of pneumonia. Patient well developed and nourished. Heart and left chest normal. The right chest showed dullness at the base, râles and bronchial breathing. Cholecystostomy for acute cholecystitis (?) performed, patient in dorsal position. The anæsthetic was gas and ether, 6 ounces, and was administered for a period of 15 minutes. Operation lasted 25 minutes, and the patient was unconscious for 1 hour and 30 minutes. The anæsthesia was of a good general character with no accumulation of mucus and no vomiting. On return of consciousness, the patient was nauseated and vomited. The patient made a fair recovery, but pulse and respiration steadily rose. In 24 hours the right back was solid, with râles and bronchial breathing. White blood corpuscles 14,000 day of operation, two days later 12,000. The patient died. No autopsy.

CASE 2. M. G., male, age 14, December. Diagnosis, subacute appendicitis (?). Patient fairly well developed and nourished, with heart normal. The right upper back and both bases showed dullness with râles. Appendectomy performed (no real process), patient in dorsal position. The anæsthetic was gas 50, oxygen 10, and ether 1 ounce, and was administered for a period of 45 minutes. The operation lasted 40 minutes. Patient was unconscious for 3 hours. Anæsthesia was well taken. There was no mucus, no nausea, or vomiting on return of consciousness. Patient made good recovery on pneumonia règime, but had pain in back and increase of signs in right back. After 4 days patient better by lysis. Discharged, relieved.

CASE 3. W. J. P., male age 5, April. Diagnosis, foreign body (pin) in trachea. Patient's left chest dull and breath sounds distant; no râles or bronchial breathing. Heart normal; temperature 104°; pulse 136; respiration 50. Œsophagoscopy and bronchoscopy performed, tracheotomy with removal of pin from trachea, patient in Rosers' position. The anæsthetic was ether, small amount, well taken. Patient made fair recovery. Bronchial breathing over area previously dull within 24 hours. Crises on the fourth day. Discharged, relieved, on the twelfth day.

CASE 4. J. F. D., male, age 44. Diagnosis, megacolon and duodenal ulcer. Patient in good condition, thin but well developed. Heart and lungs normal. Anterior gastro-enterostomy per-

formed, patient in dorsal position. The anæsthetic was gas and ether, 20 ounces, and was administered for a period of 1 hour and 40 minutes. Operation lasted 1 hour and 26 minutes, and the patient was unconscious for 3 hours and 30 minutes. The anæsthesia was poorly given and taken. Respiration irregular and poor; color variable; and vomiting during operation. Patient made poor recovery, rapidly failed. Clinical evidence of pneumonia only slight. Died in 12 hours, probably of shock. Autopsy: lobar pneumonia; chronic pleuritis; obsolete tuberculosis in apex of lung; septicæmia (streptococcus mucosus capsulatus).

CASE 5. J. McL., male, age 58, June. Diagnosis, hypernephroma with liver metastases. Patient in excellent condition, strong, well developed and nourished. Had pneumonia once, years previously. Heart normal; no murmurs. Lungs clear and resonant; no râles. Exploratory laparotomy performed, with excision nodule in liver, patient in dorsal position. The anæsthetic was ether, 14 ounces, and was administered for a period of 45 minutes. Operation lasted 30 minutes, and patient was unconscious for 2 hours and 45 minutes. Anæsthesia was well taken. Rapid operation with no struggling, mucus, or vomiting. No nausea, vomiting, or cough on return of consciousness. Patient made good recovery, but in 24 hours there were crackles in the right back; in 48 hours definite signs of consolidation. Pulse, temperature, and respiration up. Died in 4 days. Typical lobar pneumonia. Good reaction. No autopsy.

CASE 6. M. H., female, age 42, February. Diagnosis, chronic appendicitis (?), duodenal ulcer (?). Patient anæmic and undernourished. Heart normal and lungs clear. Epigastric incision, appendectomy, patient in dorsal position. The anæsthetic was ether, 10 ounces, and was administered for a period of 1 hour and 10 minutes. The anæsthesia was well taken. There was postoperative nausea, vomiting, and headache; no shock. Patient made fair recovery with some vomiting on the following day, in 24 hours consolidation at both bases. Cleared up in 4 days.

CASE 7. H. B., male, age 36, February. Diagnosis, duodenal ulcer. Patient had chronic bronchitis and coarse râles in left lung when admitted. Waited 10 days before operation. Heart normal. Infolding of ulcer and posterior gastro-enterostomy performed, patient in dorsal position. The anæsthetic was ether, 22 ounces, and was administered for a period of 1 hour and 40 minutes. Patient was unconscious for 4 hours and 45 minutes. Anæsthesia well taken. There was postoperative vomiting; no shock. Patient vomited much on day following the operation. Temperature up. In 3 days râles and friction rub, then consolidation at both bases. Cleared up in two weeks.

CASE 8. C. G., male, age 65, April. Diagnosis, pyloric ulcer. Patient an old man in fair condition. Lungs clear and normal. Pylorectomy and posterior gastro-enterostomy performed. The anæsthetic was ether, 20 ounces, and was administered for a period of 2 hours and 26 minutes. Operation lasted 2 hours, and the patient was unconscious for 3 hours. Anæsthetic was well taken. Some shock. Patient made a fair recovery. On the following day there were marked signs of consolidation in both chests. Died on sixth day after operation. No autopsy.

CASE 9. C. R., female, age 65, May. Diagnosis, carcinoma of cervix. Patient in very poor condition, anæmic, chronic bronchitis, with aneurism (subclavicular), markedly arteriosclerotic. Excision pedunculated malignant polyp, patient in lithotomy position. The anæsthetic was ether (record missing). Short operation, anæsthesia well taken. Day after operation, temperature, respiration elevated, cough. Temperature irregular 6 days; dullness at both bases; sudden rise in temperature (101°) sixth day, irrational. Died on twelfth day. No autopsy.

CASE 10. S. F., male, age 29, February. Diagnosis, duodenal ulcer and gall-bladder adhesions. Patient in excellent condition. Heart normal and lungs clear. No râles. Infolding ulcer and posterior gastro-enterostomy performed, patient in dorsal position. The anæsthetic was ether, 16 ounces, and was administered for a period of 1 hour and 42 minutes. Patient was unconscious for 4 hours, struggling in first stage; no shock. Second day there was consolidation of both bases, lasted 12 days. Recovered.

CASE 11. G. H. D., male, age 85, April. Diagnosis, fæcal fistula following perforated duodenal ulcer 9 weeks previously. Patient in fair condition. Heart and lungs clear. Resection fæcal fistula performed, patient in dorsal position. The anæsthetic was anæsthol, 3 ounces; ether, 8 ounces, and was administered for a period of 40 minutes. Operation lasted 50 minutes, and anæsthesia was well taken. No struggling; good respiration and color; no mucus. Patient made a fair recovery. Developed pneumonia on second day in left lower lobe. Died on the fifth day. White blood corpuscles 11,600 on day of death; poor reaction. Autopsy: lobar pneumonia; healed ulcer duodenum; arteriosclerosis; chronic localized peritonitis.

CASE 12. P. N. F., male, age 58, April. Diagnosis, sarcoma of the bladder. Patient had history of pneumonia 5 years previous and much coughing since. Bubbling râles both sides, no dullness; heart normal. Suprapubic cystostomy performed, patient in dorsal position. The anæsthetic was gas and oxygen, and was administered for a period of 45 minutes. Operation lasted 40 minutes and patient was unconscious for 1 hour and 10 minutes. Anæsthetic was well taken; no struggling; good condition; and no postoperative nausea or vomiting. On the second day pulse, temperature, and respiration up. Purulent sputum; pain and cough worse; third day process left base (bronchiectasis?). Died in 6 days. No examination of chest. Abdominal incision only.

CASE 13. S. S., female, age 44, December. Diagnosis, adenoma and cyst of liver. Patient in poor condition. Lungs negative, clear; heart normal. Pneumonia 3 weeks previously. Removal of cyst and contents, patient in dorsal position. The anæsthetic was gas and ether, 11 ounces, and was administered for a period of 1 hour and 30 minutes. Operation lasted 1 hour and 40 minutes, and the patient was unconscious for 3 hours. Pulse poor toward close, some shock; no vomiting. Three days after operation there was consolidation in right lower lobe. Resolution 10 days. Discharged, relieved.

CASE 14. F. St. A., male, age 70, May. Diagnosis, carcinoma of the stomach. Patient in bad condition with cardiac arrhythmia and many râles both sides. Feeble old man. Partial gastrectomy and posterior gastro-enterostomy performed, patient in dorsal position. Anæsthetic was ether 18 ounces, and was administered for a period of 2 hours and 25 minutes. Operation lasted 2 hours and 35 minutes, and patient was unconscious for 6 hours. Anæsthetic was well taken; no struggling; respiration normal; good color, fair pulse. Long operation and no evidence of shock. Patient made good recovery. Cardiac condition became gradually worse; fourth day pneumonia in right base; poor reaction. Died on sixth day. Autopsy: lobar pneumonia in right upper lobe; arteriosclerosis; chronic passive congestion; emphysema of lungs; operative lesion and cancer of stomach; septicæmia (streptococcus).

CASE 15. J. M., male, age 48, March. Diagnosis, recurrent carcinoma of the tongue. Patient had emphysematous chest with few râles. Heart normal. Resection of tongue performed, patient in reversed Trendelenberg position. The anæsthetic was ether, 16 ounces, and was administered for a period of 1 hour and 17 minutes. Operation lasted 50 minutes and patient was unconscious for 1 hour and 5 minutes. Struggling and excitement going under; no shock. Patient made good recovery, dirty mouth, could not swallow; aspirated food and saliva, worse day by day. Temperature gradually rose. Died in one week. Autopsy: hypostatic pneumonia; purulent bronchitis; streptococcus, septicæmia.

CASE 16. M. F. R., female, age 55, March. Diagnosis, pyelitis and pyonephrosis. Patient poorly nourished and old. Heart and lungs clear. Temperature 100°; bladder trouble for years, acute for 5 months. Cystoscopy performed, patient in lithotomy position. Anæsthetic was ether (record missing). Patient ran down hill steadily. On the fourth day developed a cough. Bronchial breathing both bases; progressively worse. Died. Autopsy: cystitis; right ureteritis; right pyonephrosis; left pyelitis. Lobar pneumonia (bilateral lower), septicæmia.

CASE 17. D. D., female, age 54, September. Diagnosis, cholelithiasis. Patient in fair condition; obese. Lungs normal. Systolic whiff and some arrhythmia. Cholecystectomy and appendectomy performed, patient in dorsal position. The anæsthetic was ether, 18 ounces, and was administered for a period of 45 minutes. The operation lasted 40 minutes and the patient was unconscious for 3 hours. No excitement; good general condition; rapid operation; no hæmorrhage. Anæsthesia well taken. There was postoperative nausea and vomiting. Patient made good recovery. Developed pneumonia on tenth day from which she seemed to rally. Died suddenly on twenty-fourth day. No autopsy.

CASE 18. J. Y., male, age 60, August. Diagnosis, cholecystitis. Patient in good condition. Lungs clear; no râles. Lysis of obstructing bands. Anæsthetic was novocaine, gas 25, oxygen 10, ether 8 ounces, and was administered for a period of 1 hour and 18 minutes. Operation lasted for 1 hour and 15 minutes. (Anæsthesia report incomplete.) Patient was normal for ten days; developed pneumonia on the fourteenth day. Fluid signs; 8 ounces of dirty brown, bile-like fluid with streptococci. Died in 7 days. No autopsy.

CASE 19. E. W., male, age 59, July. Diagnosis, duodenal ulcer. Patient's lungs normal; no râles. Infolding ulcer and posterior gastro-enterostomy performed. Anæsthetic was ether, 18 ounces, and was administered for a period of 1 hour and 55 minutes. Operation lasted 1 hour and 45 minutes and the patient was unconscious for 3 hours and 30 minutes. No struggling; pulse normal; no mucus; general condition normal. Patient normal for 14 days; then consolidation of right lower lobe, which lasted 10 days and then cleared up. Relieved.

Bronchopneumonia. This is the most frequent complication we have found in our series and it also falls into fairly definite groups similar to those discussed above under lobar pneumonia. First, there are certain cases in which there was a pneumonia already present at the time of the operation. Case 1 is an example. Case 2 had dyspnœa and râles on entry, and in spite of local anæsthesia developed a pneumonia which was probably incipient at the time of operation. We feel that Case 3 should be considered separately. Local anæsthesia was followed by pneumonia in two days. Our only explanation is hypostasis in a patient 56 years of age, although it is possible that some pulmonary pathology was present and overlooked in the pre-operative examination.

In the irritative group the lung condition develops within 1 to 3 days of the administration of the anæsthetic. Cases 4, 5, 6, and 7 are undoubtedly to be placed in this class.

Case 4 had had a previous anæsthesia shortly before entrance to the hospital, and this combined with the irritation of the foreign body had evidently resulted in a beginning pneumonia, which was further developed by the embarrassment of a second etherization. Case 5 was 70 years of age, and had a moderately emphysematous lung; Cases 6 and 7 depend more fully on the anæsthesia for their etiology. In 6 a profuse secretion of mucus embarrassed the anæsthesia, while Case 7 though only on the operating table one hour and thirty minutes did not recover for four hours and one-half from what must have been an unnecessarily deep anæsthesia. Case 9 may equally well be put in this group or classified under the embolic type since there was a septic focus present. Because of the previous anæsthetization we consider that it was liable to this complication. Case 10 is especially interesting as the presence of a well defined pneumonia 33 days before operation was noted. Whether there was still some slight residual process which the anæsthesia lighted up or whether it was simply an irritative type with the localization of the organisms on a previously prepared soil it is difficult to say. At any rate due precautions were taken in this case, a wait of nearly five weeks and then spinal anæsthesia with a slight amount of anæsthol, so that this is truly an "unavoidable complication." In this group of 6 cases 4 presented a pre-existing lung pathology (4, 5, 9, and 10), while the remaining cases, (6 and 7) we must admit seem to result chiefly from the effects of the anæsthesia.

The aspiration of food or mucus serves as the factor responsible for a limited number of bronchopneumonias. Cases 11 and 12 have as their definite cause the aspiration of food, and it was necessary to resort to nasal feedings in these cases. Case 8 had a definite bulbar paralysis which opened up the avenue for the aspiration of food and mucus, and adds another instance to this group. Thus, there were three cases with aspiration as the definite factor in their etiology.

In the embolic group we classify the greatest number of our bronchopneumonias. Some of these cases are part of a general process in which septic emboli lodge in the lungs and other viscera, causing pyæmia or even general septicæmia, yet we include them here because of the difficulty in drawing the lines more closely. Examples of this type are Cases 14 and 15. Case 16 showed râles and dullness in the right back before operation and a subphrenic abscess, but it was over a week before the pneumonia developed in the left chest. This may be explained by extension through either the lymphatics or blood stream as in Cases 14 and 15. Case 17 is an undoubted embolus directly following the passage of sounds. Case 18 may also be placed in the embolic group because the pneumonia did not develop until the second week and then only after moving the patient from a closed to a tent ward. The exposure, as recently suggested by Boothby (3), may have been an important contributory factor in this case.

Another interesting possibility as a factor in the causation of bronchopneumonia is frequently mentioned in the literature on malignancy. It is claimed that metastases lodge in the lung capillaries and that the inflammatory process thus aroused explains the resulting pneumonia (Keen, 22). If this is so, it is possible to account for Cases 19, 20, and 21 of our series. Our pathological sections of the lung were too limited to allow a thorough investigation along this line, but in such slides as were available we were unable to locate any malignant tissue.

Case 22 is included here for completeness only, for it is secondary to a mediastinitis with extension to the lung tissue, and is discussed under that heading.

Case 1. J. B., male, age 50, May. Diagnosis, inguinal hernia. Patient's lungs had dullness and râles on right side. Radical cure (Bassini) and appendectomy through hernia sac performed; patient in dorsal position. The anæsthetic was ether (no record); long operation. Following operation patient's temperature up one week. Patches of bronchopneumonia.

Case 2. E. I. L., female, age 63, January. Diagnosis, umbilical hernia. Patient in fair condition; dypsnœa; numerous râles; very fat; no murmurs in heart. Anæsthetic was local (novocaine, 1 per cent). Next day temperature, pulse, and respiration up. White blood-corpuscles increased. Bronchopneumonia both bases. Lived 3 days. No autopsy.

Case 3. J. L., male, age 56, August. Diagnosis, inguinal hernia. Patient normal; lungs clear with

slight systolic murmur. Radical cure performed with patient in dorsal position. Local anæsthesia administered. Two days after operation temperature, pulse, and respiration up. Pneumonia right base. Recovery in 6 days.

CASE 4. F. G., male, age 1½, November. Diagnosis, peanut in trachea (several hours duration). Breath sounds modified with many râles and crackles, especially in left. Bronchoscopy, tracheotomy, and extraction performed, patient in dorsal position. Ether anæsthetic administered (no record). Dyspnœa day following operation; temperature 106°. Two days later bronchial breathing left base. Temperature 105°. Small area of dullness. Ten days later much sicker, same signs; then cleared up rapidly.

CASE 5. H. M., male, age 70, October. Diagnosis, duodenal ulcer. Patient old man with emphysema; no râles. Infolding and posterior gastro-enterostomy performed, patient in dorsal position. The anæsthetic was ether, 20 ounces, and was administered for a period of 1 hour and 25 minutes. Operation lasted 1 hour and 7 minutes, and the patient was unconscious for 4 hours and 25 minutes. The anæsthesia was well taken. Day following operation dullness and râles; bronchial breathing and patches which lasted 9 days; then cleared.

CASE 6. J. R., male, age 20, May. Diagnosis, inguinal hernia, right. Patient in good condition; lungs normal. Radical cure (Bassini) performed, patient in dorsal position. Anæsthetic was ether, 14 ounces, and was administered for a period of 1 hour and 10 minutes. Operation lasted 1 hour, period of unconsciousness doubtful; much mucus. On second day patient had patch of pneumonia at right base which lasted 1 week.

CASE 7. L. Z., female, age 40, November. Diagnosis, fibromyoma uteri and lacerated perineum. Patient in excellent condition; heart and lungs normal. Supravaginal hysterectomy, salpingo-oophorectomy, and perineorrhaphy performed with patient in Trendelenberg and lithotomy positions. Anæsthetic was gas and ether, 12 ounces, and was administered for a period of 1 hour and 25 minutes. Operation lasted 1 hour and 15 minutes, and the patient was unconscious for 4 hours and 20 minutes. Respiration shallow; otherwise normal. Two days later developed pneumonia; pain in chest. Pulse, temperature, and respiration normal in 6 days. Recovery. Home on twentieth day.

CASE 8. F. P., male, age 38, January. Diagnosis of abscess of brain (?); final diagnosis, acute non-suppurative myelitis. Patient well developed and nourished. Lungs normal; bulbar paralysis. Right subtemporal decompression performed, patient in dorsal position. Anæsthetic was ether (record not available). Patient died on following day; no lung findings recorded clinically. Autopsy: focal pneumonia; left lobe, scattered.

CASE 9. E. C. S., female, age 3, March. Diagnosis, osteomyelitis radius. Patient in excellent condition. Incision, curettage, and drainage performed, patient in dorsal position. Anæsthetic was ether (2 operations). Second operation, ether, 2 ounces, was administered for a period of 15 minutes. Operation lasted 15 minutes and the patient was unconscious for 30 minutes. Struggling and excitement; pulse 128. After operation patient developed cough. White blood-corpuscles, pulse, temperature, and respiration elevated, patches in left lung; normal in 2 weeks.

CASE 10. W., male, age 34, July. Diagnosis, compound fracture of both bones of the leg. Patient on entry had pneumonia in right back. Diagnosed clinically and by X-ray; waited 33 days for lung condition to subside. Open reduction and bone plate performed, patient in dorsal position. Anæsthetic was spinal, stovaine 1.5 cubic centimeters. Anæsthol, 3 ounces, administered for a period of 45 minutes. Operation lasted 1 hour. Anæsthesia was well taken. Day following operation temperature 101°, pulse 100, respiration 28 to 30. No report in history on condition of lungs. Up in one week.

CASE 11. W. E., male, age 64, January. Diagnosis, carcinoma of the tongue. Patient in good condition with heart and lungs normal; no râles. Dissection of neck in first stage; partial excision of tongue; second stage 15 day interval, patient in Trendelenberg position. Anæsthetic was ether, 14 ounces, and was administered for a period of 1 hour and 15 minutes. Operation lasted 1 hour and 2 minutes, patient unconscious for 1 hour and 45 minutes. Patient made good recovery; had difficulty in swallowing and was fed by nasal tube. Two days later pain in chest; in 3 days dullness in right back. Became gradually weaker and developed cough in 10 days. Fluid and patchy consolidation in right back. Died in 22 days. Autopsy: empyema and bronchopneumonia, right; emphysema; purulent bronchitis.

CASE 12. L. S., male, age 2, March. Diagnosis, retropharyngeal lymph-glands, tuberculosis, and septicæmia. Patient in poor condition; labored breathing; lungs normal. Tracheotomy performed, patient in dorsal position. Anæsthetic was ether (no record). Patient had aspirated feedings. Second day after operation developed dullness and bronchial breathing in right upper lobe. Died. No autopsy.

CASE 13. I. G., female, age 11 months, April. Diagnosis, deep abscess in neck, otitis, pyelitis, abscess in leg and septicæmia. Patient in poor condition; temperature 103°; pulse 138; respiration 48; stupor. Patient very sick. Incision and drainage of abscess of neck performed. Anæsthetic was ether (no record). Patient developed within 3 to 4 days a patch at left base which cleared gradually.

CASE 14. A. B., female, age 4 months, January. Diagnosis cervical adenitis and empyema. Patient had eczema all her life. Worse on scalp now than ever. Patient well developed and nourished with heart and lungs normal. Incision and drainage of cervical abscess twice. Anæsthetic local (twice).

Three to four days later developed râles with shifting dullness; X-ray showed scattered lesions. Died in 3 weeks, 4 hours following a chest tap; fluid was thick, amber colored. Autopsy: confluent bronchopneumonia, empyema, and septicæmia.

CASE 15. G. W., male, age 65, November. Diagnosis, hypernephroma. Patient poorly nourished with lungs normal. Nephrectomy performed, patient in lateral kidney position. Anæsthetic was ether (no record). Patient had irregular temperature and pulse on day following operation; no note, continued irregular. On twenty-third day had sudden rise in temperature to 104°. Died on twenty-ninth day after operation; râles throughout right chest. Autopsy: septicæmia (streptococcus); suppurative pneumonia; chronic pleuritis; abscess of right knee, arteriosclerosis.

CASE 16. F. B., male, age 16, December. Diagnosis, subphrenic abscess. Patient in poor condition. Heart and lungs normal. Scattering râles and dullness in right back. Incision and drainage performed. Anæsthetic was gas and oxygen; short operation. Anæsthetic was administered for a period of 20 minutes and the operation lasted 10 minutes. Patient was unconscious for 20 minutes. Patient made fair recovery, but no improvement followed. Better for a few days, then developed pneumonia on the eighth day in left chest. Died on fifteenth day. Suspicious of right pneumonia all the time. No autopsy.

CASE 17. J. M., male, age 70, November. Diagnosis, stricture urethra. Patient old man with emphysema; in good condition. Perineal section performed, patient in lithotomy position. Anæsthetic was ether (no record). Patient did nicely for 10 days; sounds passed and on next day patches in left chest. Died in 3 days. No autopsy.

CASE 18. R. C., male, age 41, July. Diagnosis, pyelitis. Patient in normal condition except for complaint. Temperature 102.6°; respiration 35. Appendectomy with drainage performed. Anæsthetic was gas and ether (no record). Patient made good recovery. On fourteenth day (2 days after transfer to tent) had chill. Pneumonia for 1 week, then normal.

CASE 19. H. C., female, age 58, November. Diagnosis, carcinoma of the breast. Patient in poor condition with râles both sides; systolic murmur. Amputation of breast and dissection of axilla performed. Anæsthetic was ether, 13 ounces, and was administered for a period of 1 hour and 15 minutes. Operation lasted 1 hour and 20 minutes, and patient was unconscious for 2 hours and 55 minutes. Small amount of nausea and vomiting on return to consciousness. Patient made a good recovery. In 2 weeks had gradual onset of bronchopneumonia; rapidly worse. Died on twenty-sixth day. No autopsy.

CASE 20. C. McC., male, age 60, May. Diagnosis, carcinoma of stomach. Patient in fair condition; obese; $A_2\times$ emphysema; shady past history; suspicious of chancre. Anterior gastroenterostomy performed, patient in reversed Trendelenberg position. Anæsthetic was ether, 17 ounces, and was administered for a period of 1 hour. Operation lasted 45 minutes and patient was unconscious for 2 hours and 30 minutes. No postoperative trouble; anæsthesia well taken. Patient made poor recovery; cyanotic; clammy. In 10 hours, bronchopneumonia at left base, no improvement with stimulation. Died in 30 hours. No autopsy.

CASE 21. C. P., male, age 45, February. Diagnosis, brain tumor. Patient in fair condition with heart and lungs normal; marked cranial pressure; total disorientation. Subtemporal decompression, right, performed. Anæsthetic was ether. No especial shock; short operation lasting 1 hour. Patient made no real recovery. Pulse and temperature up at once. Disorientation. Died. Autopsy: hypernephroma; bronchopneumonia in right lower lobe; perforation of œsophagus; metastasis of brain.

CASE 22. D. O'D., male, age 50, November. Diagnosis, carcinoma of the tongue fully presented under mediastinitis.

Bronchitis. In the discussion of this pulmonary complication it must be pointed out that there are undoubtedly many more cases of bronchitis than are here recorded. Often the house officer fails to make a note on a transient condition of this kind, and consequently, unless it is of a more severe nature it is not properly classified in the hospital records. The cases discussed here had a severe bronchitis, in no case clearing up under 6 days. We have divided the group into simple uncomplicated bronchitis and bronchitis complicated by association with other lung pathology. Two cases had pathological processes in the lungs previous to operation, and it seems reasonable to assume that the ether acted as an irritant and assisted in the dissemination of the already present focus.

Case 1 is an example of poor surgical judgment. We feel that the man in this case was exposed to an unnecessary surgical risk in that his condition, duodenal ulcer, was not one which demanded immediate surgery and that operation could well have been deferred to a time when the lesion at the right apex was quiescent. Case 5, on the other hand, can be placed in the excusable surgical risk class as the gastric carcinoma demanded operation at once, and the lung pathology of necessity was a secondary consideration. The fact that 9 ounces of ether were poured on the cone

for a short operation of 30 minutes points to a factor that might have been better controlled in this case. Case 2 must be put down as an irritative type since on the day following operation his lung pathology was marked and his previous condition was normal. Unfortunately his anæsthesia record was missing so that a complete criticism cannot be made. Cases 3 and 4, however, had considerable trouble with the anæsthesia and there was much mucus and difficulty in getting free exchange in the lungs in both cases. Case 3 stopped breathing and artificial respiration became necessary. The amount of mucus mentioned had probably a direct bearing on the etiology in these cases and we think they properly belong in the anæsthesia-aspiration class. In Case 3, the trauma of artificial respiration is an additional predisposing factor. It is this type especially in which we feel that a more expert anæsthesia would serve to diminish such complications. Case 6 occurred in a man who was at the outset a very poor risk. He had had a previous transfusion to prepare him for his second operation, and his bronchitis may be regarded as a natural occurrence in a run down individual who has been exposed to long etherization.

Bronchitis in association with other lung pathology is both natural and obvious. There is one case, 7, which merits a more complete discussion. To begin with, there was evidence of pre-operative lung pathology at the right base. After a long epigastric operation, the patient was in a fair condition for 6 days. At that time there was a rise in temperature, bronchial breathing, and profuse expectoration which continued with about the same intensity for one month. A succession of pleuritic rubs, phlebitis in the popliteal region, and more friction rubs followed, and throughout the next month there were signs in both lungs which were variously interpreted. The medical consultants considered the diagnosis to be probable diffuse capillary bronchitis, or at most bronchiectasis on account of the profuse sputum. The X-ray, on the other hand, showed an area of density in the left upper lobe which was considered to be a possible lung abscess. The subsequent course, during which the patient made a gradual but complete recovery, seems to confirm the medical view rather than the roentgen-ray findings, and we have classified the case as a severe diffuse capillary bronchitis. It is a well known observation, nevertheless, that a small percentage of lung abscesses heal without surgical interference (Lord, 1).

In this group, 3 of the 7 cases presented definite pre-operative lung pathology, one was so anæmic that a transfusion was necessary to prepare him for operation, and a fifth case had artificial respiration on the table and an anæsthesia which was very poorly taken throughout. Post-operative pulmonary complications were almost to be expected in these individuals. The effects of anæsthesia may be held responsible for the remaining two cases.

CASE 1. F. S., male, age 28, September. Diagnosis, duodenal ulcer. Patient slim; dullness in right apex; sibilant râles; diminished breathing in whole right lung. Whispered fremitus is greater in right apex. Pylorectomy and posterior gastro-enterostomy performed, patient in dorsal position. Anæsthetic was gas and ether, 14 ounces, and was administered for a period of 1 hour and 25 minutes. Operation lasted 1 hour and 25 minutes and patient was unconscious for 2 hours and 35 minutes. Struggling, excited; otherwise anæsthesia was well taken. No nausea or vomiting on return to consciousness. Day following operation temperature 101°–102°; pulse 130; respiration 34. Cough. Recovery in 6 days.

CASE 2. M. B., male, age 30, August. Diagnosis, cholelithiasis. Patient well developed and nourished; lungs clear; no râles. Anæsthetic was gas and ether (record missing). Day following operation; râles; much sputum. Temperature 101° and pulse 90 to 100, descending in 6 days.

CASE 3. H. T., male, age 52, March. Diagnosis, duodenal ulcer. Patient well developed and nourished; lungs clear, no râles. Infolding ulcer and posterior gastro-enterostomy performed, patient in dorsal position. Anæsthetic was ether and was administered for a period of 1 hour and 40 minutes. Operation lasted 1 hour and 25 minutes and patient was unconscious for 2 hours. Anæsthesia was poorly taken; stopped breathing at the start; artificial respiration; respiration irregular throughout. Considerable mucus, nausea and vomiting on return to consciousness. Six days after operation temperature 101°; respiration 30. Râles all over chest; cleared in 2 days. Two day interval then temperature rose to 102°; respiration 35, clearing 6 days later. Another attack with sore throat and cough lasted 3 days; then normal.

CASE 4. R. C., female, age 34, March. Diagnosis, cholecystitis. Patient well developed and nourished with lungs and heart normal; no râles. Cholecystectomy performed with patient in dorsal position. Anæsthetic was ether, 8 ounces, and was administered for a period of 45 minutes. Operation lasted 40 minutes and patient was unconscious for 2 hours and 20 minutes. Considerable mucus; anæsthesia well taken. No vomiting on return of consciousness. Few days after operation bronchitis fairly severe; 8 days later, râles in both lungs but no dullness; subsided 3 days later.

CASE 5. M. C., female, age 48, July. Diagnosis, carcinoma of stomach. Patient well developed but poorly nourished; lungs show dullness in left apex. Exploratory laparotomy, inoperable carcinoma, patient in dorsal position. Anæsthetic was ether, 9 ounces, and was administered for a period of 40 minutes. Operation lasted 30 minutes and patient was unconscious for 1 hour and 40 minutes. Anæsthesia was well taken; no vomiting on return to consciousness. Had temperature 101° for the first 7 days after operation. No note as to cause. Note on records eighth day, cough and râles, mostly at bases, more right; diminished resonance; bronchial breathing; no consolidation; 16 days clearing up. Still had râles on discharge.

CASE 6. J. M., male, age 39, August. Diagnosis, carcinoma of stomach. (Operation was for gastric ulcer. Above diagnosis made several months later on second exploration.) Patient well developed and nourished; pale; lungs normal; anæmia; transfusion before operation. Gastrotomy, cauterization for ulcer lesser curvature and posterior gastro-enterostomy performed, patient in dorsal position. Anæsthetic was ether, 16 ounces, and was administered for a period of 1 hour and 30 minutes. Operation lasted 1 hour and 30 minutes and patient was unconscious for 3 hours and 25 minutes. Pulse 70 to 94 to 116; otherwise normal. No vomiting on return to consciousness. Day following operation had cough and sputum; second day temperature 102°; pulse 120; diffuse severe bronchitis over entire chest. On fifth day patient was normal again.

COMPLICATED TYPES ASSOCIATED WITH OTHER LUNG PATHOLOGY

CASE 7. E. F. B., male, age 53, December. Diagnosis, ulcers of stomach and duodenum. Patient fairly well developed and nourished; rather thin. Heart normal; lungs slight dullness behind at right base. Excision ulcer of stomach, plication pylorus and posterior gastro-enterostomy performed, patient in dorsal position. Anæsthetic was ether 24 ounces, and was administered for a period of 1 hour and 50 minutes. Operation lasted 1 hour and 45 minutes and patient was unconscious for 4 hours and 15 minutes. General condition good; fair pulse and color; some mucus; no vomiting. Day following operation vomited large amounts of blood. Six days later had "tightness" of chest; bronchial breathing. Temperature 101°; pulse 90; respiration 25. KI given, much sputum, profuse expectoration and same chest signs for about 1 month, then pleuritic rib of left axilla, followed by phlebitis in left popliteal space. January 6, chest signs cleared. January 16, friction rub right axilla, cough, sputum through January. Medical consultants: "probably diffuse capillary bronchitis or bronchiectasis." February 2, X-ray shows area of dullness left upper lobe; "lung abscess, too diffuse for operation." February 15, lungs cleared again but cough continued. Gradually chest signs and cough disappeared. Discharged relieved.

CASE 8. J. M., male, age 48, March. Diagnosis, recurrent carcinoma of tongue. Resection of tongue performed; fully presented under lobar pneumonia.

In the pneumonia and bronchitis groups we have tried to demonstrate that in addition to the effects of the anæsthesia, factors predisposing to lung complications are almost invariably present. We do not mean by this that the anæsthesia plays no part in the resulting pulmonary processes, for we agree with Kelling (47) that the aspiration of mucus and mouth contents during anæsthesia constitutes an important factor in the production of these lesions. We wish to emphasize, however, that this latter factor alone unless augmented by sepsis in the mouth or indifferent administration of the anæsthetic is seldom sufficient to cause lung complications. In all but 5 of the 47 cases in these groups, factors were present in addition to the anæsthesia.

Pleurisy. Cases of postoperative pleurisy as well as of bronchitis often fail to be recorded, and we feel that there must be many others unavailable for this series. Seven cases are reported. We have divided the cases into two classes; simple, dry plastic pleurisies, and pleurisies complicated in some manner, as by effusion or association with other lung conditions. We are inclined to believe that the ordinary dry type is usually the result of an embolic process, a small sterile blood-clot breaking off at the site of operation and finding lodgment in the distal lung capillaries. The associated inflammatory reaction due to infarction leads to friction rub and pain, and the postoperative history seems to bear this out. The onset is as a rule sudden, usually at about the end of the first week or ten days, when the patient begins to be more active, the pain and friction

immediate, and there is no accompanying fever or leucocytosis. Cases 1, 3, and 4 appear to be definitely of this class. Case 2 had a very evident etiology in a tuberculous lung process, which was recognized before operation. Due precautions as to anæsthesia were taken in this case, but when the nature of the operation is considered it seems to us that it was unnecessary and that the result might have been expected. The medical consultants regarded the postoperative condition to be of tuberculous origin and the association of pleurisy with this etiological factor is so well known as to merit no further discussion.

The one case of pleurisy with effusion has a probable explanation in that the patient had extensive carcinoma with metastases. On the seventeenth day after operation, when the patient was up and moving around preparatory to discharge, she had sudden pain in the chest, possibly a metastasis, and two days later a rapid accumulation of fluid to the level of the right scapula.

Cases 6 and 7 complicated by association with other lung conditions such as pneumonia are clearly only a part of the larger pathological process and have been more fully discussed under the latter classification.

UNCOMPLICATED (DRY, PLASTIC) TYPE

CASE 1. A. B., female, age 44, November. Diagnosis, cancer of stomach. Patient well developed and nourished, with heart and lungs normal. Posterior gastro-enterostomy performed, patient in dorsal position. Anæsthetic was gas, and ether, 12 ounces, and was administered for a period of 1 hour and 15 minutes. Operation lasted 1 hour and 15 minutes and the patient was unconscious for 3 hours and 15 minutes. No struggling or excitement; pulse and respiration good during operation. No nausea or vomiting on return to consciousness. Eleven days after operation patient developed pain in right costal margin which was increased by inspiration. Question as to pleurisy cleared up in 4 days.

CASE 2. E. B., female, age 40, January. Diagnosis, dysmenorrhœa. Patient had hæmoptysis 6 months before admission; on admission had dullness in right chest. X-ray showed old pathological process of right chest which suggests pyogenic process. Dilatation and curettage performed, patient in lithotomy position. Anæsthetic was gas and oxygen, and was administered for a period of 20 minutes. Operation lasted 15 minutes and the patient was unconscious for 20 minutes. No struggling or excitement; color fair; general condition normal during operation. Pleurisy probably started before operation and continued. Medical consultant considers it tuberculosis.

CASE 3. G. F., female, age 48, February. Diagnosis, fibroids of uterus. Patient well developed and nourished; lungs clear; heart normal. Hysterectomy and appendectomy performed, patient in Trendelenberg position. Anæsthetic was ether, 17 ounces, and was administered for a period of 1 hour and 28 minutes. Operation lasted 1 hour and 18 minutes and patient was unconscious for 3 hours and 20 minutes. Respiration irregular; pulse 120; color fair. No nausea or vomiting on return to consciousness. Seven days after operation patient developed pain in left axilla. Rub was heard next day, and lasted for 10 days. It then cleared up.

CASE 4. M. C., female, age 37, March. Diagnosis, extra-uterine pregnancy. Patient in poor condition, and sallow; lungs normal. Salpingo-oophorectomy performed, patient in Trendelenberg position. Anæsthetic was ether, 5 ounces, and was administered for a period of 35 minutes. Operation lasted 25 minutes, and patient was unconscious for 1 hour and 25 minutes. Condition poor throughout; pulse 130. No nausea or vomiting on return to consciousness. Twelve days after operation patient developed pain in right side; friction rub. Was well in 3 to 4 days.

COMPLICATED TYPE. 1. WITH EFFUSION

CASE 5. A. E., female, age 28, August. Diagnosis, carcinoma of the stomach. Patient poorly developed and nourished; pale; slight dullness at right apex behind; no râles; systolic murmur at apex. Exploratory laparotomy of carcinoma of stomach and liver performed, patient in dorsal position. Anæsthetic was ether, 12 ounces, and was administered for a period of 45 minutes. Operation lasted 45 minutes, and the patient was unconscious for 3 hours. Respiration shallow at first; pulse 80 to 98. No nausea or vomiting. Seventeen days after operation patient was up and ready to go home. Developed pain in right chest which became greater on breathing. Temperature 100.2°; dullness; distant bronchovesicular breathing and diminished voice sounds at right base. Two days later signs of fluid to spine of scapula. Tapped; 8 ounces of thick jelly-like fluid obtained. Septicæmia; (streptococcus). Died five days later. Autopsy: Carcinoma of stomach; extensive metastases to liver, adrenal and lymph glands. Serofibrinous pleuritis; œdematous lungs; chronic pleuritis, left; streptococcus septicæmia.

2. ASSOCIATED WITH OTHER LUNG PATHOLOGY

CASE 6. A. B., female, age 4 months, January. Diagnosis, cervical adenitis. Incision and drainage of cervical abscess performed, patient in dorsal position. Fully presented under bronchopneumonia, Case 14.

CASE 7. J. Y., male, age 60, August. Diagnosis, cholecystitis. Cholecystostomy and lysis of obstructive bands performed, patient in dorsal position. Fully presented under lobar pneumonia, Case 18.

Empyema. Postoperative empyemata are sufficiently common to demand discussion in such a paper. They constitute, however, a class which we have found rather difficult to place within definite limitations. First, being of an embolic nature, they fuse into the other complications of lung abscess, pulmonary embolism, pleurisy, and embolic pneumonia. Indeed, it is only because the embolus is septic that they differ from certain of the pleurisy cases. Second, one must be careful not to classify the terminal empyemata in this group. Thus we have excluded cases developing a postoperative pneumonia with an empyema in the fatal stage. An example of this is the above case, 3, more fully discussed under the pneumonias. The other two cases, 1 and 2, are definitely uncomplicated empyemata of embolic origin. Both had sepsis present, then a sudden attack of pain in the chest with pulmonary signs developing rapidly thereafter. The most probable explanation in these cases is that a small septic thrombus becomes dislodged from the neighborhood of the field operated upon and plugs one of the peripheral lung capillaries close to the pleura. A small abscess forms which breaks through the pleura resulting in empyema. The suddenness of onset forces the opinion that they are embolic and not simple bacterial invasion. It is only because of the bacteria present that empyema and not simple pleurisy results. The mechanism is the same. Case 1 died probably from a combination of evils. The patient was 61, had an insufficiently drained abscess at the site of his bowel perforation and the primary thoracotomy gave only poor drainage. General toxæmia resulted, and the necessary second thoracotomy was too much for his already weakened resistance. Case 2, on the other hand, was a strong man of 40 with low-grade sepsis in his legs. His thoracotomy, moreover, was excellently placed at the bottom of the infected cavity and gave perfect drainage. Recovery became only a question of time.

UNCOMPLICATED TYPE

CASE 1. J. F., male, age 61, October. Diagnosis, perforated duodenal ulcer. Patient's heart and lungs normal; well developed and nourished; 12 hour perforation, distention, boardlike abdomen. White blood corpuscles 25,000. Closure of perforation with drainage performed, patient in dorsal position. Anæsthetic was novocaine, gas, and oxygen. Operation was short. Anæsthesia was well taken. Patient made excellent recovery, but had septic wound. Twenty-six days postoperative pain in left chest. Temperature 103°; dullness. Operation for empyema in 33 days. After operation but little improvement. Forty-five days later second operation for empyema. Died. Autopsy showed abscess at site of perforation; empyema (drained); septicæmia.

CASE 2. T. J. S., male, age 40, March. Diagnosis, varicose veins, bilateral. Patient had pneumonia when 28 years old. Ulcers of legs for 15 years. Patient well developed and nourished with heart normal. Lungs: rare râle; unproductive slight cough for 10 days before operation. Anæsthetic was ether, 30 ounces, and was administered for a period of 2 hours and 45 minutes. Operation lasted 3 hours and patient was unconscious for 4 hours. Anæsthesia was well taken; cough, nausea, vomiting, and headache on return to consciousness. Patient made good recovery, wounds septic. Seventh day developed sudden pain in right chest; prostrated; vomited; cough in 2 days with rise in pulse; temperature and respiration; dullness. Right chest tapped: pus. Local anæsthetic, operation for empyema. Discharged relieved with small sinus.

COMPLICATED TYPE ASSOCIATED WITH OTHER LUNG PATHOLOGY

CASE 3. W. E., male, age 64, January. Diagnosis, carcinoma of tongue. First dissection of neck and second partial excision of tongue performed at 15 days' interval, patient in dorsal position. Fully presented under bronchopneumonia, Case 11.

Mediastinitis. Postoperative mediastinitis is another complication which we believe is present in a direct relation to the pre-operative risk (including the location and type of lesion) and to the type of operation performed. Thus we feel that the morbidity statistics are here open to definite improvement. We have defined three chief sources for such infection and with each source the risk is obvious and at times preventable. In operations about the mouth with a dissection of the neck at the same time, in any operation upon the neck, especially in the presence of sepsis, and in instrumentation of the œsophagus, trachea and bronchi, the danger of a subsequent mediastinitis is considerable.

We present three cases, all with a fatal termination. They include an example of each of the classes enumerated above and because of the high mortality involved, we urge that especial attention be paid to this type of risk. Case 1 with tracheotomy in a case of carcinoma of the larynx we feel is a justifiable calamity. The operation was imperative because of obstruction to breathing so that a consideration of the risks of aspiration or of a descending sepsis need not be discussed. Case 2 was a good pre-operative risk. Here, however, criticism is justifiable. Death resulted from sepsis traveling down the neck along the planes opened up by the neck dissection. We feel strongly that such cases should be done in two stages. Had this man had his neck dissection first and the open planes given time to heal solidly or vice versa, we feel sepsis would not have traveled downward. As it is, his death may be justly attributed to an unnecessarily radical operation. Case 3 is an excellent example of the third class with the postoperative complication of mediastinitis. It may still be a mooted question whether the dilatation of cancers of the œsophagus is worth while in the presence of the danger of mediastinitis following it, but there can be no question but that lesions definitely diagnosable by the fluoroscope should not be exposed to operative manipulation with the œsophagoscope. Such is certainly unjustifiable curiosity and does surgery much harm.

Case 1. A. T., male, age 59, March. Diagnosis, carcinoma of larynx. Patient had labored breathing; lungs normal. Tracheotomy performed, patient in reverse Trendelenberg position. Convalescence prolonged; septic wound; mediastinitis; bronchitis 15 days after operation. Diffuse patches in lungs and died 46 days after operation. No autopsy.

Case 2. D. O'D., male, age 50, November. Diagnosis, carcinoma of tongue. Patient well developed and nourished; lungs clear. Resection of tongue and floor of mouth and dissection of right side of neck, patient in dorsal position. Anæsthetic was gas and ether (no record). Day following operation temperature 101°–102°; pulse 120; respiration 35. Never came down. Died on fourth day. Autopsy: phlegmon neck; serofibrinous pericarditis; suppurative mediastinitis; bronchopneumonia of lower lobe, left lung; chronic pleuritis; arteriosclerosis; septicæmia (streptococcus mucosus capsulatus).

Case 3. W. T., male, age 63, April. Diagnosis, carcinoma of œsophagus and stomach. Patient old, but fairly well developed and nourished; arteriosclerosis; cachectic; heart and lungs normal. Partial resection of carcinoma of œsophagus through œsophagoscope performed, patient in Roser's position. Anæsthetic was ether (no record). Next day pain beneath sternum. Temperature 104°; respiration and pulse up. Dullness in left base. râles behind over whole left lower lobe. Died on third day. Autopsy: cancer of stomach involving lower end of œsophagus and regional lymph-nodes. Perforation of stomach near junction with œsophagus; phlegmon of peri-œsophageal, retropericardial, and retropleural tissues.

Pulmonary embolism. Pulmonary embolism is correctly called one of the "justifiable surgical calamities." It snatches its victims without warning and indiscriminately. No type of operation and no state of pre-operative risk is without this danger. We have found in the records for the year studied 6 cases thus classified. In two cases, 3 and 4, autopsies were performed and the diagnosis corroborated by the finding of large emboli in the pulmonary arteries. The autopsy on Case 3 was personally observed and a large rider embolus bestrode the bifurcation of the pulmonary vessel practically totally occluding the right and left branches. In Case 4 the finding was much the same.

The time of onset varied from a few hours to 14 days and, with the exception of Case 6, onset and death were sudden and almost instantaneous. In the two cases autopsied sepsis was present and drainage free. And in both of these cases the embolism followed unusual activity. Case 3 had just tried his first day out of bed and immediately before death was moved in bed in an effort to make him more comfortable; while Case 4 had the dressing changed, a rubber tubing drain being replaced by rubber tissue, just previous to his sudden collapse. Cases 1 and 5 occurred shortly after operation and could have been due to the sliding away of a fresh thrombus from the operative field. The picture in the latter case is not so clear since the question of mechanical obstruction at the larynx or of interference with the important nervous structures in the neck must enter into our consideration. Case 2 differs from the cases previously discussed in that there was no

sepsis present and that it could not have been a fresh thrombus easily dislodged since it occurred 11 days after operation. It is then to be considered as a case of venous thrombosis, in which because of activity an already organized and large thrombus broke loose and brought its inevitable result. Such cases are not unusual, and Kelly of Baltimore and Ranzi (5) of Vienna have well discussed the frequency of such calamities in gynecological operations. Case 6 is not so well defined and the correctness of the diagnosis of embolism may be reasonably questioned. Except for his long-standing jaundice, however, this case presented a good risk and the marked dyspnœa and cyanosis though of unusual duration may be well taken as evidence of a pulmonary embolus which though not sufficient in size to cause immediate death, either through subsequent thrombosis and aggrandizement or inability of the patient to stand the added strain, terminated fatally. The pulse was weak and rapid and cardiac failure may have been the principal factor, but thorough stimulation brought no relief and before operation heart action and the physiological test of his previous active life gainsaid any such subsequent breakdown.

CASE 1. H. B., male, age 45, September. Diagnosis, carcinoma of the tongue. Patient in excellent condition; no illness until present illness; well developed and nourished. Lesion of tongue for 3 months; heart and lungs clear; no murmurs; no râles. Radical operation; one stage dissection of left side of neck, division jaw, removal of tumor and tongue "en masse;" bone plate to jaw, patient in dorsal position. Anæsthetic was gas and ether, 18 ounces, and was administered for a period of 1 hour and 50 minutes. Operation lasted 2 hours and 30 minutes and patient was unconscious for 3 hours and 55 minutes. Anæsthesia was well taken; good color; pulse 120; no struggling or excitement. Patient made excellent recovery. At midnight was normal and slept in naps until 4 a.m. Soon after became a little restless, sat up in bed suddenly, sank back and died in a few seconds. No observations of respiratory difficulty. No autopsy.

CASE 2. M. C. F., female, age 54, October. Diagnosis, procidentia uteri. Patient obese old woman, womb trouble for 7 years. Heart and lungs clear; no murmurs; sounds distant; pulse fair; no râles. Amputation cervix, anterior and posterior colporrhaphy and ventral fixation performed, patient in lithotomy and Trendelenberg positions. Anæsthetic was novocaine and ether, 9 ounces, and was administered for a period of 2 hours. Operation lasted 2 hours and patient was unconscious for 2 hours and 30 minutes. Anæsthesia was well taken; pulse 88 to 100; good color. No postoperative nausea, vomiting or cough. Patient made good recovery. On tenth day wound clean and solid. On eleventh day suddenly fell back very dyspnœic and died in a few minutes. No autopsy.

CASE 3. F. A. A., male, age 43, January. Diagnosis, appendicitis with abscess. Patient had one previous attack; present attack of 12 hours' duration. Patient well developed and nourished but gray look; local tenderness and spasm. Heart sounds normal; lungs clear. Appendectomy for retrocæcal appendix performed, necessary to mobilize cæcum, free drainage, patient in dorsal position. Anæsthetic was ether, 30 ounces, and was administered for a period of 1 hour and 40 minutes. Operation lasted 1 hour and 30 minutes, and patient was unconscious for 3 hours and 50 minutes. Considerable struggling and excitement; general condition poor; long hard operation; pulse 120. Postoperative nausea, vomiting, cough and hiccough. Patient made fair recovery. Had vomiting and hiccoughing and distention for 8 days. Stormy convalescence which cleared up. On fourteenth day sitting up, subjectively fine. Pulse, temperature and respiration rose a little. On seventeenth day comfortable at 6:30 p.m., at 7:30 p.m. dizzy spell, heart action weak and irregular, restless, some improvement. At 8:15 p.m. died suddenly without marked pulmonary distress. Autopsy: pulmonary embolism and thrombosis with plugging at bifurcation pulmonary vessels. Pelvic abscess, localized; septicæmia (streptococcus); dilated heart.

CASE 4. H. G. M., male, age 27, May. Diagnosis, tuberculosis of kidney. Patient's general condition good. No loss of weight; present trouble one year. Patient well developed and nourished; heart normal; abdomen negative; no c. v. t.; lungs clear; no râles or rubs. Left nephrectomy with drainage performed, patient in lateral position. Anæsthetic was gas 80, oxygen 20, and ether small amount, and was administered for a period of 1 hour. Operation lasted 1 hour and patient was unconscious for 1 hour and 15 minutes. Anæsthesia was well taken and general condition normal. No struggling; no vomiting. There was some postoperative nausea. Patient made good recovery. Temperature, pulse and respiration slightly elevated, drained well. Condition improved after eighth day. Dressing tenth day at 8:15 p.m.; rubber tube taken out and replaced by rubber tissue drain which was followed by headache and nausea. At 10.15 p.m. was dizzy and faint; position changed, fainted twice, rallied, rational. Respiration became dyspnœic, pulse 104 of fair quality. Respiration and pulse suddenly ceased. Autopsy: pulmonary embolism; streptococcus septicæmia.

CASE 5. M. M., female, age 53, July. Diagnosis, deep cervical adenitis. Patient for 4 days had

swelling in throat with dyspnœa, was well developed and nourished. Lungs and heart clear; temperature 100°; mass under ramus jaw on right side. (1) Incision and drainage for cervical adenitis and (2) tracheotomy for œdema glottis, patient in dorsal position. Anæsthetic was anæsthol (no record). After first operation patient in poor shape, dyspnœa marked. Tracheotomy performed with great relief at 12:45 a.m. Comfortable at 1:45 a.m. and normal; at 1:50 a.m. respiration dropped to 5, also marked failing in character of pulse. No dyspnœa. Died suddenly. No autopsy.

CASE 6. J. T., male, age 71, May. Diagnosis, carcinoma of bile ducts. Patient in normal condition until present illness. Painless jaundice for 1 month Patient well developed and nourished; lungs clear above; squeaks and râles at bases. Systolic murmur at apex of heart; moderate arteriosclerosis. Cholecystectomy and choledochostomy performed, patient in dorsal position. Anæsthetic was ether, 16 ounces, and was administered for a period of 1 hour and 50 minutes. Operation lasted 1 hour and 37 minutes, patient unconscious for 4 hours and 45 minutes. Had jerky respiration; pulse 100 to 120; general condition fair; no vomiting. Patient made good recovery and was normal for 24 hours. On third day temperature went down and pulse up (100). At 6 p.m. pulse rapidly began to fail; weak and rapid dyspnœa and cyanosis; marked stimulation of no avail. Died before midnight. Went to pieces rapidly but not suddenly. No autopsy.

Pneumothorax. The postoperative complication of pneumothorax admits of little discussion since its etiology is definitely mechanical and hence ovbious. Operations close to the attachments of the diaphragm always offer this possibility and necessarily operations on the kidney give us the greater percentage of such complication (Quimby, 53). We would like to point out, however, that in this discussion we have not included pneumothorax following operation on the lungs, as such a result is practically always to be expected. However, it is rarely a fatal complication in this latter class, although in the past year one of the deaths following thoracotomy for lung abscess was probably due to this complication. Both cases in our series were the result of operations for the removal of a kidney, and both recovered. Unless sepsis is present or the immediate shock too great, we feel the prognosis is good without treatment. Quimby (53) advocates immediate closure of the tear with support of the mediastinum by forceps if the collapse and symptoms are marked, and aspiration of the pleural cavity after operation.

CASE 1. S. S., female, age 22, February. Diagnosis, infected hydronephrosis. Patient in good condition with lungs normal. Nephrectomy, left (small hole torn in pleura, immediate closure), performed with patient in lateral kidney position. Anæsthesia was gas 300, oxygen 20, and ether 4 ounces, and was administered for a period of 1 hour and 5 minutes. Operation lasted 1 hour and patient was unconscious for 2 hours. Anæsthesia was well taken; slight nausea on return to consciousness. Some shortness of breath next day; absence of breath sounds; left side hyperresonant. Roentgenogram showed left lung collapsed. Aspiration; following day signs nearly same as before aspiration. Gradually cleared up.

CASE 2. A. S., male, age 28, April. Diagnosis, hypernephroma. Patient well developed and nourished with chest normal; good risk. Nephrectomy, right, twelfth rib resected, pleura opened during maneuver and closed immediately; patient in lateral position. Anæsthetic was ether, 16 ounces, and was administered for 1 hour and 30 minutes. Operation lasted 1 hour and 6 minutes and patient was unconscious for 3 hours and 30 minutes. Mucus and vomiting during operation. Five days after operation temperature 100°; pulse 100; respiration 30. Night of sixth day, sudden severe attack of dyspnœa, temperature 101.2°; pulse 120; respiration 34. Next day temperature and pulse came down; recovery excellent; no treatment for pneumothorax necessary.

Lung abscess. In our studies no well defined case of postoperative lung abscess was found. Unquestionably some of the empyema cases occurring after operation begin in a small abscess, embolic in origin, at the periphery of the lung, but the picture of empyema is the more prominent and cure results in the treatment of this condition. One case, 7, in the postoperative bronchitis class, was possibly a real abscess, but it was never definitely proved so. Lord (1), however, has remarked that a certain proportion of the lung abscess cases do heal without operation. So the final cure in this case is no definite proof against the diagnosis of abscess. Pirie (6), in a recent article, has shown how valuable X-ray findings are in the diagnosis of lung abscess, and it is our opinion also, that this diagnostic method is of the greatest importance. Therefore we hesitate to be arbitrary in the classification of the above-mentioned case. That it stands alone is an argument pointing to the relative in-

frequency of the condition in general surgery. Lord (1) has found that in operations confined to the nose and throat, the incidence of lung abscess is high. In his series 10 per cent of the cases of lung abscess followed operations in this field.

EMPYEMA AND LUNG ABSCESS

In our analysis we have deliberately avoided classifying in this study the postoperative pulmonary complications of empyema and lung abscess, since it is apparent that the incidence of some further pulmonary lesion will reach 100 per cent. By removing these groups, we feel that we present a more accurate picture of the postoperative complications of general surgery which we have under discussion. To justify this stand, we offer a short summary of each of these groups as they occurred in the year's work under analysis.

There were 23 cases of empyema operated upon, with 4 deaths, a mortality of 17 per cent. In over 90 per cent of these cases pneumonia preceded the empyema and in a large proportion it had not entirely subsided at the time of operation. Cardiac failure on the table was charged with the responsibility in three of these four fatalities, and it is best explained by the too rapid change in intrathoracic pressure allowing a dilated heart to become more fully embarrassed. The fourth case died of prolonged sepsis following operation. Pulmonary complications were present in every instance; always pneumothorax, frequently bronchitis, and often a residual pneumonia. A further factor, imperfect drainage, made a second operation necessary in three cases. A distressing complication encountered in a certain number of cases was the fact that a persisting sinus remained at the time of discharge from the hospital, and it is this type which probably constitutes the large class of chronic empyema cases that infest the outpatient clinics of every large hospital. We feel that the chief factor responsible for this condition is the failure to establish drainage at the most dependent portion of the infected cavity.

There were 11 operations for lung abscess. In every case, there was at least a transient bronchitis, and four cases ended fatally. Two were followed by empyema, one by pneumothorax, one by hæmorrhage, and three terminated by cardiac failure. The technique of operation was the same in every case. First a preliminary thoracotomy under anæsthol anæsthesia with an attempt to promote pleuritic adhesions either by sutures or a gauze pack. After a suitable interval, secondary exploration of the lung was done, with the hope that the first operation had excluded the general pleural cavity, and that drainage might be established through a previously prepared opening. The difficulties of this surgical problem are emphasized by the resulting complication of pneumothorax and empyema in spite of the preliminary care taken to avoid these sequelæ.

To include such groups under the postoperative complication of general surgery would seem hardly fair and might give a false impression of the dangers and risks involved.

COMPARISON WITH STATISTICS FROM OTHER CLINICS

In making comparisons it is desirable to get statistics from clinics which fulfill the same general requirements as our own if possible. We have found this to be especially difficult on account of the diversity of our surgical pathology, and because of the fact that our active emergency service brings us all kinds and conditions of men and surgical risks. To compare our figures with those from the Mayo Clinic (7, 8 and 9), would seem inconclusive and unfair to the quality of our work, for we feel that in Rochester there is an entirely different clientele. This in part may explain the discrepancies between the morbidity and mortality reports from such institutions and our own. It is easy to see how in a clinic such as that at Rochester, where there is a minimum of septic and emergency work, and where a previous train ride, often of days, has tested out the pre-operative risk to a considerable extent, there should be a decidedly lower mortality result. And, again, we have also to remember that the surgery in a general hospital such as the Massachusetts General is not confined to a small group of operators, but that many surgeons and much

variety in preparation and technique contribute to the final statistics in such an institution. Consequently, we feel that reports from the large general hospitals in the big cities are much more valuable in giving us a picture of the pulmonary complications that are liable to arise in general surgery.

We have gathered together such summaries of the pulmonary complications following general surgery as we have encountered, and present them in chart form.

GENERAL SURGERY — ALL LUNG COMPLICATIONS

Reference	Number of Cases	Pulmonary Morbidity	Morbidity Per Cent	Mortality	Mortality Per Cent	Mortality Per Cent of Morbidity
Mayo* (Beckman, 7), 1910	3657	41	1.12	9	0.24	21.9
Mayo* (Beckman, 8), 1912	5835	92	1.57	6	0.10	6.5
Mayo (Beckman, 9), 1913	6825	87	1.27	0	0.00	0.0
V. Eiselsberg (Ranzi, 5)	6871	263	3.8	†	†	†
Montreal General Hospital (Armstrong, 10)	2500	55	2.2	32	1.28	58.1
Massachusetts General Hospital (E. C. C. and J. J. M)	3490	65	1.86	33	0.94	50.7
Osnabrueck (Otte, 11)	7 years total cases	..	‡	‡	‡	‡
(Pfannenstiel, 20)	2000+	..	§	§	§	§
Combined Statistics (v. Lichtenberg, 51)	23,673	440	1.9	..	..	..

*Amended to include pulmonary embolism.
†Not recorded for whole series.
‡No lung complications.
§No deaths from lung complications. No pneumonia.

It is noted that in the large general city clinics, the incidence of lung complications varies from 1.8 to 3.8 per cent. But it is the mortality figures that are most interesting. Unfortunately Ranzi (5) did not present his mortality statistics so that we cannot use his report for comparison, but the Montreal General Hospital shows a very similar figure to the mortality percentage of morbidity in our own summary. It is the pneumonias and the embolism cases that contribute most largely to the deaths.

In contrast to the figures of Ranzi (5), Armstrong (10) and ourselves are those presented by Beckman (7, 8 and 9), Pfannenstiel (20), and Otte (11). At the Mayo Clinic, although they were unable to prevent altogether the incidence of pulmonary complications, they were fortunate in that they had an extremely low mortality from this score. Pfannenstiel (20) and Otte (11) were successful in abolishing the pulmonary complications entirely, a truly remarkable record. There are many factors that help explain their excellent results — very careful selection of cases, good risks, careful preparation, careful anæsthesias by the same trained anæsthetist, operations by the same group of surgeons, etc. These men deserve commendation for the prophylactic measures taken against the lung sequelæ.

The Mayo Clinic figures have been slightly changed by us to include pulmonary embolism under the pulmonary complication figures, in order to compare with the reports of the other clinics. The incidence of pulmonary complications has been in an almost constant ratio to the number of cases in the Mayo Clinic, but the mortality figures in those cases developing pulmonary complications have shown a marked improvement from 21.9 per cent in 1910 to 0.0 per cent in 1913. The factors responsible for this change are not cited but would be of undoubted value to others in the solution of this problem.

Total figures, including those of von Lichtenberg, give 52,851 cases, 1043 of which developed a postoperative pulmonary complication (1.9 per cent). This means that in every 50 cases operated upon, one will develop a lung complication. These figures may not appear so serious until the mortality statistics are consulted. Here we find grounds to make any surgeon hesitate, for postoperative pulmonary conditions invariably have a higher mortality than in these diseases when uncomplicated by surgery. Thus in our clinic 50.7 per cent of those developing lung complications died; i.e. in every 106 cases operated upon one died from such a lesion.

In contrast to the limited number of reports on general pulmonary complications, the literature abounds with articles on postoperative pneumonia. The accompanying chart — General Surgery, Postoperative Pneumonia — comprises the statistics on this score from some of the large clinics in this country, and in Europe.

GENERAL SURGERY — POSTOPERATIVE PNEUMONIA

Reference	Number of Cases	Pneumonia Morbidity	Morbidity Per Cent	Mortality	Mortality Per Cent	Mortality Per Cent of Morbidity
Mayo (Beckman, 7) 1910	3657	10	0.27	5	0.14	50.0
Mayo (Beckman, 8) 1912	5835	19	0.32	6	0.10	31.5
Mayo (Beckman, 9) 1913	6825	27	0.39	0	0.00	0.0
Roosevelt Hospital, N. Y. (L. S. B., 12)	2612	23	0.9	7	0.26	30.4
N. Y. Hospital, (F. W. B., 13)	1413	15	1.06	7	0.50	46.6
Massachusetts General Hospital (E. C. C. and J. J. M)	3490	40	1.14	22	0.63	55.0
Montreal General Hospital (Armstrong, 10)	2500	30	1.20	22	0.88	73.3
Leipzig (Laewen, 14)	9755	180	1.8	113	1.15	63.0
Presbyterian Hospital, N. Y., (A. O. W., 15)	1902	42	2.2	....	....	....
	37,989	386	1.01			
Excluding Presbyterian Hospital, N. Y.	1,902	42				
Totals	36,087	344	0.95	182	0.50	52.9
Osler and McCrae, 17)	130,101	499	0.35	....	....	....

With the exception of the Mayo Clinic reports, which are unusually low, the average hospital surgery is complicated by postoperative pneumonia in approximately 1.5 per cent of the cases operated upon, and, even including the statistics from the Rochester clinic, about 1.0 per cent develop pneumonia. This factor alone is likewise responsible for 0.5 per cent of the total average mortality of any large surgical clinic. Of the patients who develop this complication somewhat over 50 per cent will be unable to combat the added burden successfully. This is the probable reason for the attention that has been given to pneumonia as a complication of general surgery. The sources of Osler and McCrae's statistics were not available, and we present them merely as additional evidence of the incidence of postoperative pneumonia. Their figures correspond most closely with those from the Mayo Clinic and are relatively low.

When it is further considered that the majority of the postoperative pneumonias probably belong to the Group IV type of organism as reported by Whipple (15), it seems that the general condition of these patients must be a deciding factor, because the usual Group IV organism is of relatively low virulence (Dochez and Cole, 16), and would not of itself account for more than 50 per cent of the total number of fatalities. Compared with the average mortality for pneumonia, these figures are almost double; in fact they correspond more accurately with the figures for the mortality of this disease in the physically infirm, which is estimated at 53 per cent (Osler and McCrae, 17).

Pulmonary embolism has received a considerable share of attention because of the ruthless way in which it strikes down apparently favorably convalescing individuals. Wilson (46) has collected the Mayo Clinic statistics covering a period of 22 years in an endeavor to throw some light on this obscure subject. He shows that in every 1352 operations embolism is to be expected once; a percentage of 0.07. The factors considered responsible for the etiology are injury to the vascular walls, slowing and stagnation of the blood stream, disintegration of the blood corpuscles from toxic substances, and bacteræmia. In order to combat these conditions, he suggests the reduction of vascular traumatism to a minimum; early free movement on part of the patient, and measures to reduce bacteræmia; i.e., destruction of local foci of infection with cautery, and preliminary vaccine treatment when the invading organism can be isolated. Kelly, of Baltimore, had previously called attention to the possibility of trauma to the large vessels in the etiology of this complication. Ranzi (5) in his report from von Eiselsberg's clinic, Vienna, treats embolism in a more sweeping manner, including under the term not only true pulmonary embolism, but also the embolic lung infarctions, and the purulent processes, lung abscess and empyema, arising from small septic emboli. We have taken up these latter under a different grouping, so that only the first portion of his report, viz., true pulmonary embolism cases need be considered in this comparison. Fatal embolism with plugs demonstrable in the pulmonary arteries, or large branches, occurred 23 times out of 6871 operations, a proportion of once to every 299 cases, or 0.33 per cent. This is a much more frequent occurrence than in the Rochester clinic. Our figures represent practically the mean between these two groups: 6 cases in 3490, or once in every 581 operations, a percentage of 0.17. The average for the

three clinics shows that once in every 744 operations we can expect such a fatality, for the mortality in this complication is 100 per cent.

Pleurisy of the dry type is recorded from the Mayo Clinic 13 times in 1910 (7), 22 times in 1912 (8), and 18 times in 1913 (9). It has been uniformly of a mild nature, and but for the disagreeable subjective symptoms, which lasted as a rule only three or four days, has caused little trouble. Two cases of pleurisy with effusion were reported for the year 1910 (7) with one fatality, and no similar cases are mentioned in the 1912 or 1913 statistics. In 13,013 cases operated upon at the Presbyterian Hospital, New York, Burnham (18) found dry pleurisy following operation in 45 cases, and pleurisy with effusion (serous) 14 times, 4.53 per cent. In contrast to the dry type which is not usually accompanied by a general reaction, the pleurisies with effusion practically always have a fever ranging from 100.8° to 104°, and a moderate leucocytosis. The prognosis is also fairly good for this type. Burnham lost one of his 14 cases. The treatment which he recommends is aspiration of the fluid, and injection of 2 per cent formaldehyde in glycerine if the culture of the fluid shows bacteria present. Effusion is most frequent following acute abdominal conditions associated with peritonitis according to this observer. Bibergeil (19) in 3909 laparotomies had 16 cases of pleurisy with effusion, or 10 per cent of all his respiratory complications. In the Massachusetts General Hospital, pleurisy with effusion has been relatively infrequent, but one case occurring during the year reported. This case terminated fatally. There were in addition four cases of dry pleurisy which ran an uneventful course.

Empyema, on the other hand, is a very serious complication, and is accompanied by a high mortality. Burnham (18) in reference to this point emphasizes the bad prognosis, and shows that in his six cases there was not a single recovery. All of his cases followed laparotomies, and in each the lesion was associated with peritonitis, either local or general. The diagnosis of empyema (postoperative) in these cases might be easily overlooked until the process had become advanced, because aside from the temperature chart there were no symptoms or signs to point to the existence of the condition. The absence of pain, cough, or symptoms referable to the chest should be especially noted. Burnham concludes that a turbid or purulent effusion in the chest following laparotomy requires immediate drainage, and should lead at once to exploration of the subphrenic space, because of the frequent association of these two conditions. Bibergeil (19) in his 3909 laparotomies had 13 cases of empyema, with no mortality figures given. We were fortunate in having only two cases of postoperative empyema; one of these made an excellent recovery after a well placed thoracotomy operation and the other case died. The latter case falls into the category described by Burnham since there was present a localized peritonitis.

Bronchitis following operation is such a transient and non-fatal complication that there are very few available reports on this condition. The Mayos had 12 cases in 1910 (7), 39 in 1912 (8), and 18 in 1913 (9). None of these resulted fatally. We found 6 cases with no fatality.

Numerous observers have noted that pulmonary complications and especially pneumonias are more prone to follow laparotomies than operations elsewhere, so that a large bibliography has arisen around this point. The reports on pneumonia following abdominal operations are gathered together here in chart form.

LAPAROTOMIES — PNEUMONIAS (POSTOPERATIVE)

Reference	Number of Cases	Morbidity	Morbidity Per Cent
Zurich (Kroenlein, 21)	1409	8	0.56
Massachusetts General Hospital (E. C. C. and J. J. M)	1181	20	1.7
Breslau (Kausch, 44)	1881	45	2.4
Hamburg (Kuemmel, 43)	1754	43	2.5
Berlin (Bibergeil, 19)	3909	135	3.5
Heidelberg (Czerny 42)	1302	52	3.9
Leipzig (Laewen, 40)	1829	98	5.4
Munich (Gebele, 41)	1196	77	6.43
Breslau (Henle, 29)	1787	143	8.0
Koenigsberg (Wolff, 45)	971	121	12.5
Average morbidity	....	...	4.7

From this chart one can see that the average figure, 0.95 per cent, for postoperative pneumonia in general surgical conditions is increased five times when abdominal surgery alone is taken into consideration. Why should such an increased incidence exist? To explain this we believe there are many factors concerned. First, the abdominal group of operations represents a large percentage of emergency surgery, oftentimes accompanied by septic processes. The consequent exposure in the preparation of the patient, and in the operation itself, is much greater, and the general pre-operative risk is not so good as in the other groups of conditions. Our figures for this group are proportionally low. This surprises us for our clinical observations had led us to the impression that following laparotomy we had a high percentage of pulmonary complications. Analysis of our statistics shows that it is the epigastric operations in which the high percentage of complications occurs. A large number of our laparotomies are explorations of the pelvis for gynecological conditions and we feel that this field offers less danger from such complications. The statistics from gynecological clinics bear this out. Otte (11) reports no pneumonias from the Osnabrueck clinic covering observations during 7 years while Robb and Dittrick (39) had 6 pneumonias in 1007 cases, only 0.58 per cent.

Kelling (47) and Bibergeil (19) in a careful study of the factors concerned in the production of pneumonia following laparotomy conclude that other than the general factors (age, anæsthesia, vasomotor influences, pain, etc.) there is present the possibility of extension of abdominal sepsis through the numerous pathways of the blood and lymphatic systems. These observers lay the greatest stress on the presence of sepsis either as a pre-existing lesion or inoculated at the time of operation. Their observations are further supported by the studies of Gerulanos (52) who records the extremely high incidence of pneumonia in the pre-antiseptic days.

It is the surgery of the epigastrium, however, that offers the field par excellence for the development of postoperative pulmonary complications. We have carefully summarized our operations in this region and find that in 295 epigastric incisions for operations on the stomach, gall-bladder, pancreas, etc., 23 have been followed by pulmonary complications, a percentage of 7.7. Eleven of these 23 patients died, giving a mortality of 3.7 per cent from lung complications, and 47.8 per cent of the pulmonary morbidity in this group. We have been puzzled by this marked incidence, because it is in this field that our most experienced surgeons operate, and also where the most careful precautions are taken before and after operation. There seems to be a number of factors which may be in part responsible for the postoperative pulmonary sequelæ in this field. First, conditions are almost ideal to produce hypostatic congestion of the lower lobes of the lung. This is brought about by imperfect expansion of the lower chest due (1) to a painful wound which leads the patient to splint the part, and (2) to a tight swathe used to hold on the dressings. Add to this the long exposure and chilling of the diaphragm, and the trauma by retractors and gauze, and further still the possibilities of vasomotor disturbances by injury to the vagus or sympathetic control, and it is easy to see that congestion of the bases is bound to result. Armstrong (10), Bibergeil (19), and Kelling (47) have laid especial stress on the part played by chilling of the diaphragm in epigastric operations. They advocate the careful walling-off of the subdiaphragmatic space with hot wet packs to combat this sequel. The easy pathways of infection through the diaphragm by blood or lymphatic channels (Kelling, 47), (Sabin, 48), will allow extension to this perfectly prepared field even if the pulmonary organisms have not already taken advantage of the situation. Gee and Horder (49) state: "From the concurrence of perigastric adhesions, and adherent pleura over the diaphragm in the post-mortem room it is probable that the pleura not seldom becomes infected in gastric diseases, without perforation of the stomach." The high morbidity percentages with epigastric incisions is thoroughly discussed in the literature; Bibergeil (19) reports 5.8 per cent pneumonias and Laewen (40) 8.1 per cent total lung complications. Our own statistics show

figures midway between these two and in striking contrast to the 1.1 per cent average morbidity following general surgical conditions. A contributing factor to those already mentioned may be the method of preparation which usually leaves a patient wet on the table throughout his one to two-hour operation as the case may be.

GENERAL DISCUSSION AND SUMMARY

The field presented is so broad and diversified that it is difficult to confine any discussion within moderate bounds. Certain facts, however, stand out sharply both as shown by our own statistics, and in the comparison with the reports from other clinics. One is struck at once by the very considerable percentage of lung complications, in some clinics ranging as high as 3.8 per cent (Ranzi, 5) and 2.2 per cent (Armstrong, 10), and again by the relative freedom from such sequelæ in other clinics (Beckman, 7, 8, 9), (Otte, 11), (Pfannenstiel, 20), (Kroenlein, 21). There must be some explanation for this discrepancy in addition to the argument that the type of patient varies greatly as to pre-operative risk in the different clinics. In large hospitals such a wide variation is not probable. Furthermore in the above-mentioned reports where the percentage of complications was low, sensible and adequate explanation and reasons are presented to justify their low postoperative pulmonary morbidity. Thus Otte (11), Pfannenstiel (20), and Kroenlein (21) observed exceptional precautions before, during, and after operations. The mouths of patients were carefully cleansed with antiseptic solution before operations, expert anæsthetists were employed regularly, the preparation on the table was short and such as not to unduly expose the patient to cooling fluids, the operation was begun as soon as possible, and the most careful precautions were observed after operation to avoid any exposure to draughts, or cold air, both on the way to the wards from the operating rooms, and later in the recovery wards. Furthermore, the steady improvement in the Mayo Clinic statistics, as reported in the years 1910, 1912, and 1913, can be taken in part as an indication of the increased efficiency of anæsthesia and postoperative precautions in that clinic. The discharge of patients before the convalescence is completed renders their figures less valuable in any comparative study of statistics. In the clinics reporting high postoperative pulmonary morbidity there is no evidence of any such exceptional precautions, nor can we say they have been in use in this hospital.

From reading reports it is impossible to conclude which factor is the more important, and great stress is not laid on the same factor by any two writers. Thus one cannot say with any certainty that by improving the method of giving anæsthesia complications may be avoided, though this is the chief factor usually discussed. If it were true that by improving the method and technique of anæsthetization, postoperative pulmonary complications could be entirely avoided, then one might truly declare that there is such a thing as "ether pneumonia," i.e., a pneumonia directly dependent on the irritation of the anæsthetic. Our personal feeling is that it rarely exists as a definite entity. Exposure during or after operation, pre-existing lung pathology, or small emboli, are added factors which are usually present, and whose importance should not be underestimated. Factors of this kind in addition to the irritation of the anæsthetic were present in 37 of the 40 pneumonia cases in our series.

In the clinic of the Peter Bent Brigham Hospital, Boston, a rather alarming number of postoperative pneumonias occurred a year ago. Since then the method of anæsthetization has been the same but exceptional measures for avoiding postoperative exposure have been observed and all patients recover in warm rooms, adjoining the operating rooms, under constant observation by competent nurses. During this latter period but one postoperative pneumonia has been recorded (3). Armstrong (10), Kelling (47), Homans (2), Gerulanos (52), and Keen (22) insist on the dangers from excessive cooling of the body while under an anæsthetic, and Harmer (25) has demonstrated that chilling by cold solutions and alcohol, as used in pre-operative preparations, is injurious. In addition it is the impression of the Mayo brothers and their

colleagues (Beckman, 8), of Kelling (47), of Armstrong (10), and of Henderson (23), Magaw (24), Keen (22), and many others that a true ether pneumonia does not exist as a definite entity. In their minds, as in ours, the aspiration of vomitus or mucus, the presence of pre-existing lung pathology, or oral sepsis, or subsequent septic emboli, are more often real factors in this etiology. Hoelscher (26) and Kelly (27) have demonstrated experimentally the constant aspiration of mucus from the mouth during anæsthetization. Thus they emphasize the value of thoroughly cleansing the mouth and removing necrotic teeth and septic roots, a precaution insisted upon by Otte (11), Pfannenstiel (20), and others whose reports of the postoperative pulmonary complications are striking because of their almost total freedom from such sequelæ. Further, the high percentage of pulmonary complications following local anæsthesia (Gottstein, 28), (Henle, 29) is another argument against the rôle of the anæsthetic in the etiology of such conditions, although it must be admitted that probably the patients in whom this type of anæsthesia was used were more often the aged and bad risk cases. Yet Gottstein (28) and Mikulicz (30) report larger percentages of pneumonias after local anæsthesia than after general anæsthesia. Of our 65 cases with pulmonary complications, 4 were operated under local anæsthesia and 3 of these developed bronchopneumonia.

We are, therefore, inclined to doubt the existence of a true anæsthetic pneumonia. At the same time we do not intend to convey the idea that the anæsthetic plays no rôle in the production of such complications. On the contrary we are certain of its very real dangers, and would urge most strongly constant efforts to perfect the technique of its administration. It is not our purpose to discuss here in detail the comparative values of the cone and drop method of giving ether, but what has long been held that, by using the cone, warm ether is inhaled, thus lessen the danger of postoperative pulmonary complications, in our experience is proved untrue. As to the gas-ether sequence our observations lead us rather to discredit this method since we have both observed frequently much and alarming cyanosis with the change from one anæsthetic to the other. It may be true that the technique of performing this change is not perfected in this institution, and that concentrated ether is forced suddenly on an already cyanosed and struggling patient, but it is our opinion that the time gained is not commensurate with the risk. Not only is an increased burden suddenly placed upon the heart and intense irritation of the lungs brought about, but there must be a very considerable stimulation to the production of mucus which has been shown both experimentally and clinically to be an important factor in the causation of postoperative lung conditions. The argument that gas is far more agreeable to the patient still may hold good, but we feel that ether given carefully and slowly by the drop method is not necessarily disagreeable (Keen, 22). In fact we would point out that it is generally with patients who have previously been anæsthetized with ether by the cone method that we find any such deep rooted dislike toward this drug.

Poppert (31) has shown experimentally the dangers of a too concentrated ether vapor and Hoelscher (26) has demonstrated the dangers of the inhalation of mucus while under an anæsthetic. Further experimental evidence, Offergeld (32), Poppert (31), von Lichtenberg (33), Ladd and Osgood (36), stamp the open-drop method as the far safer course, and Magaw (24), Boothby,[1] Bevan (34, 35), Kroenlein (21), Keen (22), Herb (4), etc., confirm this method from clinical observation and experience. Gatch (50) well summarizes the experimental results dealing with the effects of ether vapor upon the lungs as follows: "The irritant action of ether vapor varies with its concentration; postoperative lung complications are frequently caused by the aspiration of mouth contents. The greater severity of the pulmonary lesions found after experimental etherizations by the closed method can be satisfactorily accounted for by the great concentration of ether vapor in the closed masks, and the greater liability to aspirate mouth contents when these are used." A more recent article by Herb (4) confirms

[1] Personal communication.

these findings from clinical observation and experience; and in addition denies the advantages of warm ether vapor, an advantage claimed for the cone method.

Otte (11), Pfannenstiel (20), and Kroenlein (21) show excellent figures when anæsthesia has been carefully administered and such experienced anæsthetists as Henderson (23) and Magaw (24) state the rarity of pulmonary complications when the anæsthetic is in skilled hands. Armstrong (10) after studying his statistics places the greatest importance on a skilled anæsthetist as one of the chief factors in preventing these complications. The evidence, therefore, is overwhelming that the anæsthetic if poorly administered may be to some extent to blame. Keen (22), Gwathmey (37), Boothby, Bevan (34, 35), Henderson (23), and Magaw (24) all insist on the greater safety of ether over other anæsthetics, so that we consider that the discussion of other anæsthetics in this paper is unnecessary. We feel, however, that it is only fair to state that a large proportion of the German statistics which we have reviewed come from clinics where chloroform narcosis was employed.

Throughout this study we have been much impressed with the necessity of keeping full anæsthesia records if we are ever to learn betterment from our mistakes. In this hospital the anæsthesia record is kept separately on slips of paper that have several desirable features, more especially in that there is a pre-operative part to be filled out by the house officers, an anæsthesia record to be filled out by the anæsthetist, and a postoperative part to be filled out by the nurse in the ward when the patient has become conscious. It is unfortunate, however, that these slips are not filed away with the histories, but kept separately, and that the part involving the actual anæsthesia is not full enough. We would like to point out what has been so strongly advocated by Gwathmey (37), Keen (22), Bevan (34, 35), Boothby (38), and others that an actual chart record is the best form on which to keep such data. During our investigations we became so convinced of the importance of this point that we consulted the anæsthesia records and charts of various American institutions, and evolved the accompanying sheet, which we present as a form that includes the data necessary to permit future studies on the advantages or disadvantages of certain anæsthetics, and on the course and mistakes of certain types of operations. It follows in general form the very excellent chart in use at the Peter Bent Brigham Hospital, Boston, and will probably be put in use in this institution (Figs. 1 and 2).

We have entered into this thorough discussion of the relation of anæsthesia to postoperative pulmonary complications because we feel that not only is it the factor most constantly present but it is one which by care and betterment of methods can be to a great extent eradicated. And although our analysis has led us to believe that this factor alone is really sufficient to cause postoperative pneumonia it certainly plays a very important contributing part.

In studying further the relation of anæsthesia to the postoperative lung complications we thought there might be something of value in a consideration of the seasonal occurrence since there is unquestionably a seasonal increase in the incidence of pulmonary lung disease.

We present a postoperative pulmonary complication chart for one year (Fig. 3).

Other writers have also plotted the seasonal incidence of their pulmonary complications, and Armstrong (10) shows that of his 55 cases 35 occurred in the five months November to March, while of the 35 complications reported by Robb and Dittrick (39), 20 occurred in the four months January to April. Thirty-nine of our 65 cases came within the six-months period November to April. This is even more significant when it is realized that the hospital is only at its fullest capacity during the other six months when but a little over one-third of the total complications occurred. The percentage calculations as plotted on the chart shows this strikingly. Osler and McCrae (17) state that the majority of pneumonia cases occur during the interval November to June.

A consideration of some of the other predisposing factors brings forward more interesting data. The average age of the 65 cases

ANÆSTHESIA CHART

Ward..... Service..... Date of Operation.....

Name..... Age.....

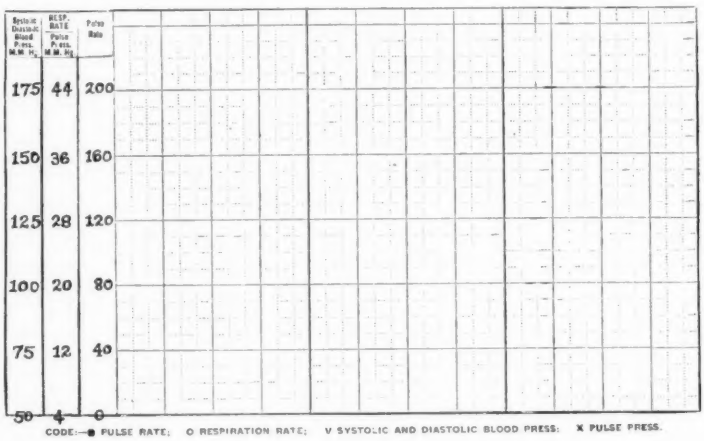
Lungs..... Heart.....

Operator..... 1st Asst.....

Operation..... Preliminary Drugs.....

Anæsthetic..... Amount..... Method of Adm.....

Note:—Record of time of starting anæsthetic, beginning of operation, removal of anæsthetic, and close of operation very important.


Systolic Diastolic Blood Press. MM. Hg.
RESP. RATE Pulse Press. MM. Hg.
Pulse Rate
175 44 200
150 36 160
125 28 120
100 20 80
75 12 40
50 4 0
CODE:—● PULSE RATE; O RESPIRATION RATE; V SYSTOLIC AND DIASTOLIC BLOOD PRESS; X PULSE PRESS.

REMARKS:

Struggling or excitement?..... Mucus?.....

Vomiting?..... Cyanosis?.....

ADDITIONAL REMARKS:

Drains.....

Closure.....

Stimulants.....

Anæsthetist.....

Fig. 1.

with pulmonary complications was 43½ years. It varied from 57 for the mediastinitis cases and 50 for both the lobar pneumonia and empyema groups to 39 for the bronchopneumonias.

In 26 cases some definite lung pathology was demonstrable at the time of operation. Other writers have also laid especial stress on this factor. Bibergeil (19), in reviewing German statistics, records that of 200 lung complications reported by Kelling, 13 showed bronchitis before operation. Thirty-four of these developed pneumonia and 17 died — 8.3 per cent. This is in striking contrast

POSTOPERATIVE OBSERVATIONS:

Conscious at .....

Nausea .....

Vomiting .....

Headache .....

Cough .....

Thirst .....

.....

Sig. of Nurse.

Note:—P. T. and R. when ordered taken at frequent intervals should be recorded on the Anæsthesia Chart.

Fig. 2. Reverse side of chart.

to the operations on patients with normal lungs where only 3.0 per cent died. In a few of our cases a pneumonia although undoubtedly present before operation was missed entirely; in several cases emphysema or a few coarse râles were noted before operation. Septic foci, including the lung conditions and cholecystitis, appendicitis, ruptured bowels, etc., were present in 39 cases, almost 60 per cent. The importance of septic foci in relation to subsequent lung complications has long been repeatedly shown in statistical studies. It is this factor which is responsible for the large proportion of the embolic complications. The greater number of such cases occur with abdominal sepsis, where the anatomical distribution of blood-vessels and lymphatics facilitates the ease of extension.

The general risk we have tried to estimate and have considered the age, the pre-existing lung pathology, and sepsis elsewhere, cardiac condition and past history. The divisions are arbitrary, and those with pre-existing lung pathology we have called poor risks, 21 we have called good, 18 fair, and 25 poor risks. These figures are extremely instructive. Only imagine operating on a series of cases one-third of which have the description "poor risk" stamped on them before operation! It shows how lightly we approach operation in general and is a just criticism. Some of these factors, at least, can to a great extent be avoided, and this is one of the lessons we wish to point most sharply. Other writers, Armstrong (10), Otte (11), Kroenlein

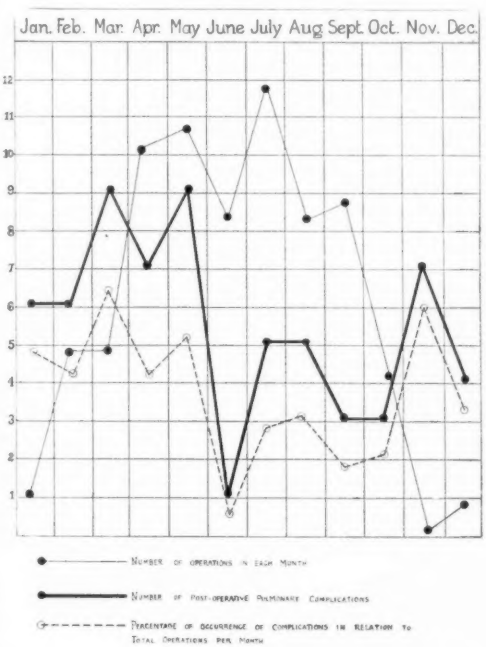


Fig. 3. Postoperative pulmonary complications. Monthly incidence.

(21), and others urge strongly the eradication of septic foci before operation. The lung condition must be thoroughly understood, and if there is any question, the operation scheduled must be put off, if possible, until improvement sets in. Of course, there always will be a few cases where the pulmonary risk is great, but in which delay overbalances the danger of immediate surgical intervention. It is interesting to record here that Otte (11) speaks of giving anæsthesia to patients with lung trouble (asthma, bronchitis, etc.), when it seemed absolutely necessary, but that by using great care with the anæsthetic, all future lung complications were avoided. At least it points a lesson from which many clinics may well take their text.

We had hoped to find another remediable factor in the long duration of some operations. But a careful study of our own cases and of the statistics and opinions of others has brought us to the conviction that the duration of the anæsthetic, *per se*, plays an unimportant part. Of course, in poorly administered anæsthesia the duration adds to the risk.

In covering the entire field of postoperative complications, we have already said that the pneumonia group stands out as the most important class, and thus we have spent much time in analyzing and discussing it, but we feel that the same factors are present to a considerable extent in producing bronchitis; i.e., the anæsthesia here, too, plays an important rôle. The pleurisy, empyema, and pulmonary embolism cases are usually embolic in origin, as is to be expected, and we feel that the discussion already presented and the exposition of our series of cases in these various groups is sufficient. Their etiology depends on some area of sepsis or thrombosis which frequently existed before operation, and which, therefore, in some cases is avoidable. The mediastinitis and pneumothorax cases are easily explainable on a mechanical basis, and need no further discussion.

We hope we have shown much room for improvement, and that such improvement is easily available with study and care in the selection of cases, in the pre-operative preparation, in the method and skill of the anæsthetist, and in the postoperative conduct.

CONCLUSIONS AND SUGGESTIONS FOR PROPHYLAXIS

Factors predisposing to postoperative pulmonary complications. From the above studies we have derived the following conclusions as to the etiology of postoperative pulmonary complications. Certain factors weigh more heavily than others, but we feel sure that no single specific cause is alone militant in any given group or type. There seems to be present always a large and varying number of factors. Anæsthesia has been repeatedly blamed as the main factor responsible for these complications, but we feel we have shown that when alone and in good hands it can be disregarded as sufficient to bring about such sequelæ. The figures we have presented from this clinic that one in every 54 cases operated upon develops a postoperative lung condition and that 1 in 106 dies, are so striking as at once to establish the importance of these sequelæ. And it should be a sufficient warning to make any surgeon consider thoroughly all the risks involved and what precautionary methods he might use in each and every case. The predisposing factors are:

1. Poor general condition, i.e., age, anæmia, alcoholism, arteriosclerosis, weak heart or susceptible lungs. (The type that appears superficially as a bad pre-operative risk.)
2. Oral sepsis; i.e., teeth carious, necrotic, etc., tonsils septic.
3. Pre-existing lung pathology — not only tuberculosis but bronchitis, emphysema or a recently subsided pneumonia.
4. Anæsthetic badly given, i.e., forced, aspiration of mucus permitted, unnecessary intubation of nasopharynx, vomiting on table, etc.
5. The presence of septic foci.
6. Too radical operations that open up, unnecessarily, pathways to the neighborhood of the lungs or to the lungs themselves.
7. Operations in the epigastrium carry the added danger of lung complication through ease of vascular and lymphatic extension.
8. Exposure to cooling fluids or to draughts (vasomotor disturbance).
9. Postoperative pain resulting in hypostasis from poor expansion.

Prophylactic measures which we suggest to avoid the occurrence of postoperative pulmonary complications:

1. Careful preparation of the mouth; all oral sepsis from teeth and tonsils eradicated, antiseptic mouth wash and extra careful brushing of the teeth the day of operation. Turner (54) emphasizes the importance of mechanical scrubbing of the mouth with citric acid, the mere use of mouth washes being insufficient.

2. Observation of patient for at least two days before operation to insure absence of lung pathology and septic foci.

3. Carefully administered anæsthesia, preferably in the hands of an expert; ether to be given by the drop method. Avoidance of mechanical appliances in mouth and nose unless indicated.[1] Surgeon to be ready to operate when patient is prepared.

4. Avoidance of exposure during preparation on the table; no unnecessary wetting, plenty of blankets. Again after operation, particular care to avoid exposure, plenty of blankets, and if the patient is recumbent, these to be pinned about the neck. Operating room temperature kept above 75° F. The liberal use of hot wet packs in laparotomies in walling-off the operative field.

5. Avoidance of trauma, especially in the epigastrium and in the neighborhood of large vessels.

6. Asepsis.

(In the special group of epigastric operations, we suggest that in addition to the above recommendations, the wound be closed with silk sutures for the fascia, so that tight supporting bandages will be unnecessary, thus, as far as is mechanically possible, doing away with splinting of the lower portion of the lung. We further advise allowing the patients more freedom of movement in bed and would not insist on the semi-erect posture always. In addition, we advocate getting the patient up and out of bed just as early as is compatible with the existing conditions in each case.)

[1] We except the introduction of soft rubber catheters into the nasal passages for the mechanical administration of ether as by the Connell machine, because we believe that the even anæsthesia more than overbalances the danger of setting loose infected material.

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FAT EMBOLISM FOLLOWING TRAUMA TO BONES

An Experimental Study of Its Production and Prevention with Particular Reference to the Albee Operation

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THE importance of fat embolism following bone injuries has recently received considerable emphasis. Buerger (1) examining the lungs of one hundred individuals who had received severe contusions or bone fractures found embolic fat lacking in only one case of severe bone injury. In his excellent monograph, Warthin (2) reports that in the eight fatalities following fractures in his pathological service, on which autopsies were performed, "all showed a marked fatty embolism as the cause of death." It is of significance to note that a clinical diagnosis of fat embolism was not made once in these cases. Le Count and Gauss (3), studying 14 cases of fat embolism, found that the symptoms had been recognized clinically only once, while the diagnosis of delirium tremens had been made eight times.

The tragic nature of fatal fat embolism in orthopedic operations has given especial significance to these cases. The dangers associated with forced straightening of ankylosed joints were pointed out by de Quervain (4) in 1904 and prophylactic measures were advocated which seemingly attracted but little attention. Von Aberle (5) made similar but more extensive observations in 1907 and outlined means of prophylaxis which are empirical in nature but have had important bearing on orthopedic procedures. The number of well-authenticated fatal cases reported, as found by Heck (6) in 1913 to be within the limits of a score, doubtlessly serves to illustrate the failure to recognize the condition rather than the rarity of its occurrence. Reiner (7) states that four deaths from fat embolism occurred in the Vienna Institute for Orthopedic Surgery alone, within the space of a few years and that three of these deaths occurred in approximately one thousand operations which were performed previous to the adoption of certain prophylactic measures. Ryerson (8) within the past three years has had three deaths, in his own service, which he attributes to fat embolism. Only in the last one of these was the cause of death definitely established. Fat embolism was not suspected at the time, in the two earlier fatalities, and consequently, no examinations were made which would reveal it. One of these cases is of peculiar interest in connection with these experiments. It was an Albee bone transplantation for the correction of a severe paralytic scoliosis. A splint cut from the tibia by means of a motor saw was sewed into a cleft made by splitting the spinous processes of the lower dorsal and upper lumbar vertebræ. The death which occurred three days later is the first one following this type of operation in which fat embolism has been reported and was responsible, in part, for the present study, undertaken at Dr. Ryerson's request.

EXPERIMENTAL PRODUCTION OF FAT EMBOLISM

The relationship which fat embolism holds to lesions of bone tissue was established by the experiments of Busch in 1866, who produced fat embolism in rabbits by boring holes in the tibias and destroying the marrow by means of a wire introduced through these holes in the cortex of the bones. These injuries to the bone marrow were followed constantly by the finding of fat droplets in the capillaries of the lungs. The animals killed at the end of three to six hours had similar amounts of fat, with the same wide-spread distribution in the lungs, as had the animals which were allowed to live several days.

Busch investigated also the method of transportation of this fat. The marrow was in part removed from the marrow cavities and replaced by an intimate mixture of

olive oil and vermilion. Large amounts of the colored fat were found in the lungs as early as 45 minutes after the completion of the operation. In these cases, no traces of pigmented fat were found in the lymph-glands along the vena cava; and the lymph-glands in the pelvis contained only small quantities of pigment.

In other animals, the vena cava was ligated below the entrance of the renal veins and a cannula inserted into its peripheral end, previous to the injection of the colored fat into the marrow cavities. When the oil was purposely injected under high pressure, the blood flowing from the cannula is said to have contained pigmented fat before the injection was completed, while three hours after the injection it was impossible to find pigmented fat even in the vessels nearest to the injured bone. On the basis of these experiments, Busch concluded that the fat is taken up from the marrow cavity largely by the veins and that the maximum of the absorption is reached during the first few hours. A much smaller amount of fat is apparently transported by the lymph.

Riedel (10) confirmed the finding of Busch that injuries to bones are constantly followed by the entrance of fluid fat into the blood stream and, in addition, showed that the intact lymph-vessels are capable of taking up fat which has been injected into the subcutaneous tissues. He never observed the production of fat embolism by this means and explained this by the emulsifying action of the lymph-glands.

While he did obtain pulmonary fat embolism with intraperitoneal oil injections, he attributed this to the supposed direct entrance of some of the lymphatics of the diaphragm into the thoracic duct without passage through lymph-glands. Fritsche (11), investigating this claim recently, could find no authority for such assumption, and states that Bartels has shown that all of these lymph-vessels pass at least one set of lymph-glands before reaching the thoracic duct. Wiener (12), likewise, obtained abundant pulmonary fat embolism by the injection of fat into the peritoneal cavity of rabbits. The lymphatics of the diaphragm were noticeably filled with fat. Olive oil injected into the pleural cavities of dogs and rabbits gave a similar result. Some of these animals were allowed to live from 13 to 19 days following the injections, but the experiments were repeated with numerous rabbits, and fat was usually found in the capillaries of the lungs in animals which were killed after two days. These experiments led to the conclusion that even the intact lymph-vessels may take up large fat droplets and that the passage into lymph-glands does not prevent the accumulation of fat droplets in the capillaries of the lungs.

The work of Ribbert (13) demonstrated the importance of jarring the bones without fracture in the production of experimental fat embolism. He found that by striking the bones of the legs of rabbits a series of blows with a mallet, a pulmonary fat embolism was produced. According to his view, the jarring of single bones, or of the skeleton as a whole, is the chief factor in bringing about the entrance of fat into the blood stream. The fat, therefore, would not necessarily come from that part of the marrow which is directly injured by the trauma, as this, he thinks, could account for only a small amount of fat. To show the relatively slight significance of the tearing of the bone marrow, when the jarring is reduced to a minimum, he produced fractures in the femurs of rabbits by a very gradually increased pressure. In these animals, no fat embolism was noted, or at most, it was slight, although the fractures were sufficiently complete for the ends of the broken bones to be moved against each other.

Ribbert thought this would explain the occurrence of marked fat embolism, in human beings, following perfectly smooth transverse fractures of bones, in which only a thin layer of marrow is disturbed, and also severe cases following very trivial fractures, or fractures of flat bones whose marrow contains but little fat, such as he had observed in fractures of the sternum, of ribs, and vertebræ, and which he had seen often in skull fractures, resulting from falls and other severe traumas.

Using Ribbert's methods, Frischmuth (14)

and later Bergemann (15) found traces of pulmonary fat embolism following the jarring of bones, unaccompanied by fracture. The repeated falling of narcotized animals from a table to the floor, or the throwing of anæsthetized animals against the wall, caused the entrance of free fat into the blood stream but, in every case, the amount of fat found in the lung capillaries was small. In this connection, Bergemann noted that the number of fat droplets, in general, seemed to be dependent upon the age of the animal and the amount of body fat which it possessed. In a few animals, in spite of the most careful searching of numerous preparations, no trace of fat embolism could be found. These preparations were usually taken from five or six different regions of the lungs and the findings in all of these were generally quite uniform; if traces of fat embolism were found in one of the preparations, they were usually found in the majority of the remaining ones. Taking all possible care to avoid jarring and shaking, Bergemann observed small amounts of free fat in the capillaries of the lungs following gradual crushing of the spongiosa of the long bones of dogs and rabbits, and also after fractures of the shafts of these bones. In these experiments, the fat droplets were larger and more numerous than those seen after the jarring of the animals. He concludes that the crushing of bones, accompanied by fracture, is of more significance in the production of fat embolism than is the jarring of bones and that some importance should be attached even to the compression of bones, since the forced straightening of joint contractures has shown experimentally in man that the compression of bones without jarring may give rise to a fatal fat embolism.

Careful experimental work in the production of traumatic fat embolism has been done also by Fritsche (11). Using rabbits and dogs, he produced fat embolism usually by one of two methods: (1) the method used by Busch of boring holes into the marrow cavity near each end of the tibias, with the destruction of the marrow by means of a wire introduced through the holes; and (2) by Ribbert's method of striking the anterior surface of the tibias 24 to 36 strokes with a mallet, avoiding injury to the soft parts and jarring of the body in general. Only in a few cases were fractures used to liberate the embolic fat. All of the animals were operated upon in deep morphine-ether narcosis, the excitement stage of ether being avoided by large doses of morphine. While in deep narcosis, they were killed by the opening of both pleural cavities, care being taken to avoid bleeding with a consequent change in the amount of blood in the vessels of the lungs. The time of these experiments, from the liberation of the fat to the killing of the animals, was usually three to four hours; a few animals were allowed to live 18 to 24 hours without any noticeable increase in the amount of fat in the lung capillaries. The examinations of the tissues for fat concerned themselves chiefly with the lungs, since no embolic fat was found in several kidneys examined after three hours.

Usually three or four blocks were removed from the lungs of each animal and sections from each of these were studied. The lungs of a number of rabbits and dogs, killed with the same precautions but without previous bone injuries, contained in some cases a small amount of intracapillary fat. Attention is here called to the fact that it is necessary to differentiate between the large embolic fat droplets and the smaller droplets found in the alveolar epithelium and in the bronchial cells. Fritsche remarks that this finding of embolic fat in the lungs of normal animals emphasizes anew the fact that a slight grade of fat embolism occurs very readily and is without significance. Only in one animal, were there no demonstrable traces of fat embolism in the lungs after each tibia had been struck 24 blows with the mallet. This was an underdeveloped rabbit, six weeks old, whose bone marrow probably contained but little fat. In an attempt to settle the much disputed question of whether fat embolism arises only through the blood vessels or whether, under certain conditions, the lymph stream can also transmit fat from the bone marrow into the circulation, Fritsche performed a further series of experiments on

rabbits and dogs. Before the production of the fat embolism by trauma to the bones, the veins from the legs of five rabbits and one dog were ligated, the collateral vessels being occluded as completely as possible. The results obtained are quite remarkable. By merely striking and jarring the extremities, in spite of the ligation of the veins, the fat droplets in the lung capillaries were found to be as abundant as they were in the controls, indicating a transportation of the fat through the lymphatics.

The importance of this route was seemingly confirmed later by the finding of large fat droplets in the lymph from the thoracic duct of animals similarly treated. On the contrary, when the fat embolism was produced by fractures of the bones or by disturbances of the marrow accompanied by hæmorrhages, the results obtained were quite different.

In these animals, the ligation of the veins prevented the collection of fat in the lung capillaries. With injuries of this kind, the fat embolism apparently arises chiefly by way of the veins. Fritsche suggests that the lymphtics may be easily closed as a result of the hæmorrhage. No hæmorrhage was ever observed in the bone marrow following the jarring of the bones in the earlier experiments. Ligation of the common iliac vein alone was not effective in preventing fat from entering the lungs, following injuries accompanied by hæmorrhage; this, however, was observed in only one animal and then 18 hours after the injury; so, in this case, the fat may have been transported, at least in part, through the lymphatics.

On the basis of these experiments, Fritsche believes that, at least so far as short-time experiments are concerned, the lymph-channels have no important part in the origin of pulmonary fat embolism following injuries involving hæmorrhages into the bone marrow; while, in connection with the jarring of the long bones unaccompanied by a tearing of the blood-vessels, the lymphatics are the chief carriers of the fat. In this latter case, the emboli formed in a given time are always less numerous than when the blood-vessels are torn.

PROPHYLAXIS AND TREATMENT

Numerous suggestions have been made in regard to prophylaxis and treatment in fat embolism, but the actual experimental work done in this field is quite fragmentary. Probably the earliest attempts in the treatment of an experimentally produced fat embolism were those of Czerny (16) in 1875. Since fat fairly easily forms an emulsion with sodium carbonate solution and, as it was known that emulsions injected into animals produced but little effect, Czerny injected fat into the jugular veins of dogs in amounts sufficient to produce dyspnœa and then introduced into the same veins, varying amounts of 2 per cent sodium carbonate solution, hoping that an emulsion would be formed with the fat in the lung capillaries. While he believed the dyspnœa was momentarily lessened, in some cases, there was no evidence of any permanent relief.

The experimental work of Ribbert (13) emphasized the importance of simple jarring of the bones in the production of fat embolism in healthy animals. He maintained that, if with a marrow which is not especially rich in fat, such as that in the bones of rabbits, this result is obtained, it would certainly occur more readily in human beings whose bone marrow is sometimes extremely rich in fat. While Bergemann (15) was unable to convince himself of the fundamental significance of this jarring and shaking, he admitted that it might be a factor. He states that if this were truly of so much importance, the use of the chisel in surgery would have to be dispensed with because of the attendant danger, and remarks that because of this possible danger, Lexer always preferred the saw to the chisel in operations on the spongiosa of bones, especially atrophic ones. Reasoning from the results of experiments similar to those of Ribbert, Wilms (17) attributed to the lymphatics a considerable importance in the transportation of fat. If we maintain that the fat is taken up by the veins, the maximum grade of fat embolism should develop in the course of a few hours, which appears to be contrary to clinical observations; in this case, he states, there would be no other means of combating its origin than to incise

the region of the injury in order to remove the fat and the blood which has escaped. He suggests that if the lymphatics serve as the chief means of carrying the fat, benefit might be secured by a temporary drainage of the thoracic duct to the exterior of the body.

This method was used by Wilms with a man 20 years of age who had fallen out of a second-story window and who later developed symptoms of fat embolism. From the fistula produced, two liters of lymph were collected during the first 20 hours after the operation. This fluid is said to have contained large droplets of fat in addition to small droplets presumably derived from ingested fatty materials. Recovery ensued and the fistula closed after four days. This observation led to Fritsche's study of the effect produced by draining the thoracic duct in rabbits and dogs, in which traumatic fat embolism was produced.

The work was limited to three rabbits and two dogs. By striking the tibias, as in the experiments previously cited, no fat droplets were found in the lung capillaries of three animals, when the lymph was led out through cannulas in the thoracic ducts, while fat droplets were demonstrable in the fluid which escaped. However, the results were quite different when holes were bored into the tibias and the bone marrow broken up, as was done with one dog and one rabbit. In spite of an abundant flow of lymph from the thoracic duct, no fat droplets were found in this fluid, but, on examination of the lungs, fat droplets were found in the pulmonary capillaries. These findings are in accord with Fritsche's conception of the different routes for the transportation of the fat in his two types of trauma to bones. In regard to the suggestion made by Wilms, he states that only in cases of shaking and jarring of the skeleton without bone fracture, would the draining of the thoracic duct be of any prophylactic value, and, in such cases, the symptoms would have to be recognized early.

On a clinical basis, von Aberle (5) in 1907 outlined a method of prophylaxis to be followed in orthopedic operations, which has received wide attention. The chief features of this method are briefly expressed as follows: (1) Since fat embolism following orthopedic operations occurs most frequently with paralytic contractures in extremities which have been long in disuse, he advocates increased care in the prevention of the formation of such contractures and of the recurrence of the condition, when once corrected. (2) Operations should be done as early as possible when once deemed necessary, since with increasing age there is increased fat content of the bone marrow, as well as danger of bone atrophy. (3) Since many of these operations are done in bloodless fields, with the use of the Esmarch constrictor, it is suggested that the fat collected in the veins may be washed suddenly into the circulation unless the constrictor is removed gradually. (4) When contractures must be operated upon, fractures should be carefully avoided and multiple contractures should never be treated all at one time; and, in case of high grade contractures, the correction should not be attempted at a single operation. If bones are accidentally broken, they should be set as carefully as possible.

Reiner (7), in the worst of these cases, has used a bloodless field in both open and closed operations, but before the removal of the Esmarch constrictor, has placed a cannula in the saphenous vein in such a way that it extends down into the femoral, so that on removal of the Esmarch, the blood, containing the fat collected from the tissues, is allowed to flow outside. Relatively large amounts of fat are said to have been obtained in this way. However, these suggestions do not seem to have been very widely adopted. Having occasionally observed convulsions following certain orthopedic operations, Schanz (18) is convinced that these might have been avoided if von Aberle's directions were followed; when they have actually appeared, he has used subcutaneous injections of salt solution, from which procedure he obtained the impression that beneficial effects resulted. This treatment is based on the assumption that the convulsions are due to the plugging up of capillaries in the brain. By this means, the capillaries can be distended and the fat droplets forced onward.

Some years before the publication of von Aberle's prophylactic measures, de Quervain (4) had emphasized the dangers associated with the compression of the spongiosa of atrophic bones and had given directions by which to avoid the dangers associated therewith. He especially recommended the use of the X-rays in diagnosis of the extent of osteoporosis and, if this were extreme, the use of forced straightening should be avoided and more gentle methods applied as previously advocated by Payr. In a recent review of traumatic fat embolism, Tanton (19) holds that the immobilization of fractures is a further factor in prophylaxis; if lipuria and dyspnœa have developed, the opening up of the fracture, with removal of the blood and fat accumulated there, should be considered. Since the beginning of the experimental work here reported, Buerger (20) has advocated the use of the Esmarch constrictor, especially in fractures accompanied by contusions, in order to hinder the further destruction of the fatty tissue by the blood and to prevent the entrance of fat into the veins; by this means also, the clotting of the blood in the crushed fatty tissues would be hastened. By experiments, to which reference only is made, he states that he has shown that fat which has become free is frequently retained by the coagulum when the blood clots. For this purpose, he says the constrictor would probably not have to be left on longer than a half hour; to hasten the clotting, gelatin might be injected before the removal of the Esmarch, but he opposes this procedure on the theoretical grounds that thrombosis might also be hastened in the vessels containing the emboli. Venesection of the injured limb, previous to the removal of the Esmarch bandage might be of some value, as suggested by Reiner. Buerger even advises Momberg's constriction at the waist line in the most severe cases, especially with crushing injuries of the pelvis.

EXPERIMENTS

The purpose of these experiments was to devise a method which would produce a relatively constant amount of fat embolism by means of trauma to bones and then, with this method, to test the value of the use of the Esmarch constrictor or tourniquet as a prophylactic measure against the fat embolism so produced, and further, to seek other means of limiting the amount of fat entering the circulation. The Esmarch constrictor has long been used for the production of bloodless fields in various operative procedures, but its use as a means of prophylaxis against fat embolism has only recently been suggested and its value never actually determined. In his directions for the prevention of fat embolism, von Aberle suggested that the Esmarch constrictor be removed gradually so that large amounts of fat would not be washed suddenly into the blood stream, but he was referring here only to those operations in which bloodless fields were being employed and does not mention its use as a prophylactic measure. Reiner, however, states that, in his worst cases, those involving paralytic contractures with marked atrophy of the bones involved, he used the Esmarch in both open and closed operations and before removing it, drained the fat-containing blood from the femoral vein. Previous to the adoption of this procedure, three fatalities from fat embolism occurred in his service. Some months after the beginning of the experimental work here reported, Buerger (20) published an article in which he strongly advocated the use of the Esmarch constrictor in bone fractures to hasten the clotting of the blood in the injured tissues and thus prevent the escape of the free fat.

Large and at least moderately well-nourished rabbits and dogs were used in our experiments.

Production of anæsthesia. To avoid the excitement stage of ether anæsthesia, a narcotizing dose of chloral hydrate was first given to all animals. For this purpose, a solution of uniform concentration was used throughout; 1 cubic centimeter of the solution was equivalent to 0.1 gram of chloral hydrate. This solution given per rectum to rabbits in the ratio of 0.3 grams of the crystals to 1 kilogram of body weight, gave a deep narcosis, beginning in 5 to 15 minutes and lasting usually about an hour. The sub-

sequent administration of ether was accomplished without much resistance on the part of the animal. With dogs a stomach tube was used and the chloral hydrate solution was introduced directly into the stomach. This method of anæsthesia while uniformly satisfactory with rabbits, sometimes failed with dogs because of the vomiting which frequently occurred. In such cases, chloroform was used to produce the anæsthesia and ether was substituted later.

Killing of animals and preparation of the tissues. In these experiments the animals were usually allowed to live 5 hours following the operation; a few were killed at the end of 2½ and 3 hours and one was allowed to live 10 hours. Some of the rabbits were killed by placing them in a large bell-jar and then gradually increasing the content of illuminating gas in the enclosed air; the remaining rabbits and all of the dogs were given preliminary doses of chloral hydrate, as in the initial anæsthesia, and this was followed by ether or chloroform. The thoracic and abdominal cavities were opened and the vessels from the lungs, heart and kidneys ligated. These organs were then removed with as little loss of blood as possible, in order that their fat-content should not be altered. These intact organs were placed in 10 per cent formalin, where they were allowed to remain for a week. Frozen sections of approximately uniform thickness (about 40 microns) were prepared and stained for fat with a saturated solution of scarlet R in a mixture of equal volumes of acetone and 70 per cent alcohol, as recommended by Warthin (2).

Estimation of the amount of embolic fat. The microscopic examination of the organs for fat was confined chiefly to the lungs, since numerous preliminary observations had shown that in these short-time experiments, fat droplets are not usually found in the capillaries of the kidneys, myocardium, and brain, as had been noted previously by others. Blocks of tissue were taken from each of the lobes of the lungs and several sections were made from each of these. To estimate roughly the amount of fat in the lung capillaries, the fat droplets in low power microscopic fields (Leitz No. 4 eyepiece and No. 3 objective. Magnification 103) were counted. In general, 20 fields were counted in each section or a minimum of 100 fields in each pair of lungs. Where the fat droplets were few, twice this number of fields was examined. The fat droplets in each section, and also in different experiments, varied greatly in size, so an attempt was made to estimate more accurately the amount of fat by recording the approximate diameter of each fat droplet in each field examined. This method was persistently followed in the later experiments, and it was noted that when the fat droplets were numerous, large droplets were proportionately more abundant; when there were few droplets, they were mostly relatively small. For comparative purposes, where only wide differences are of much significance, it is considered sufficient to report only the number of the fat droplets.

Operative procedures and results. To secure a suitable means for the production of a fairly constant and abundant fat embolism, three different operative procedures were used.

1. A slight modification of the method used by Ribbert and later by Fritsche was first tried. When the tibias of rabbits were struck numerous sharp blows with a percussion hammer, only the slightest amount of fat embolism was produced. A few fat droplets were usually found in the lung capillaries of each section examined, but often only 2 or 3 in the entire section of at least 1 square centimeter. This amount was, therefore, entirely inadequate for attempts at prophylaxis.

2. A considerably greater but still insufficient amount of fat embolism was then produced by a method similar to that used by Busch. A hole was bored in each end of each tibia and the marrow partially broken up by a wire introduced through these holes into the marrow cavity. In sections made from the lungs of two rabbits, the fat droplets found in the capillaries averaged only 1.5 per low power microscopic field.

3. The following method was then adopted: After cutting the sciatic nerves in rabbits in

order to prevent pain subsequent to narcosis, the tibias were crushed throughout practically their entire length by means of a small pipe-wrench, each leg afterward being struck approximately 36 light taps with a small wood mallet.

This is the method which was used in the first series of experiments on prophylaxis, although the amount of fat found in the lung capillaries following such procedure was not as abundant as desired for this purpose. Upon recovery from the anæsthesia, some of the animals were given liberty to move around freely, while in other cases especial care was taken to keep them quiet, to see if the amount of pulmonary fat embolism could be reduced by this means. Two of the rabbits in the first group were kept suspended in a towel provided with holes through which the legs were passed; the remaining three animals were allowed to move at will. The amount of pulmonary fat embolism is expressed in the average number of fat droplets found per low power microscopic field, as shown in Table I.

TABLE I

Rabbit	Weight Grams	Duration of Experiment Hours	Condition of Animal during Experiment	Average Number of Fat Droplets
1	2700	5	Moved at will	9.1
2	1850	5	Moved at will	14.3
3	1225	5	Moved at will	0.5
4	2250	5	Suspended in towel	8.3
5	1900	5	Suspended in towel	7.9

This table reveals considerable variations in the average number of fat droplets per field in the different animals. Numerous factors, doubtless, are concerned in the differences here noted; but, with the exception of No. 3, the disagreement is not so great as to be fatal for the present purposes, for moderate variations must be expected because of differences in the amount of fat in the bone marrow of different animals, because of the varying amounts of fat freed by the crushing of the bones, because of the much greater activity of some animals following recovery from the anæsthesia and also, because of irregularities of distribution in the lungs. The small amount of fat in the lungs of No. 3 can be explained, in part at least, by the size and condition of the animal. It was a small half-grown and poorly-nourished rabbit, whose bone marrow, like the remainder of its body, probably contained only small amounts of fat; perhaps the age factor here is fully as important as the amount of body-fat. However, even including this animal, the general average of the number of droplets per field is 8.0 and the average weight of the five rabbits is 1985 grams. In general, it was noted that, with the same amount of injury, a larger amount of fat embolism is produced in the larger and heavier animals.

No benefit seems to have been gained here by suspending the two rabbits in towels attached to a suitable frame. Whether this procedure had the desired effect of preventing trauma to the injured limbs, may well be questioned. The unnatural position occasioned considerable struggling which, undoubtedly interfered with the occlusion of the vessels by thrombi.

In the next group of experiments, Esmarch constrictors were placed on the legs of rabbits, proximal to the joint between the tibia and femur, previous to the crushing of the tibias. These rubber bandages were about 90 centimeters long and about 2.5 centimeters wide and were applied with sufficient tension to prevent the entrance of blood into the more distal portions of the extremities. They were removed at varying intervals after the crushing of the tibias and the effects noted, as in Table II.

TABLE II

Rabbit	Weight Grams	Duration of Experiment Hours	Esmarch Constrictor	Condition of Animal during Experiment	Average Number of Fat Droplets
6	2450	5	On full time	Moved at will	0.1
7	2375	5	On 2½ hours	Moved at will	0.5
8	2550	5	On 2½ hours	Moved at will	3.1
9	2550	5	On 2½ hours	Very active	4.1
10	2950	5	On 2 hours	Quiet with chloral	0.5
11	2250	5	On 2 hours	Suspended in towel	2.2
12	2300	5	On 2 hours	Suspended in towel	1.1
13	1875	5	On one hour	Distinctly quiet	1.2
14	1975	5	On one hour	Moderately active	6.9
15	2475	5	On one hour	Moderately active	2.6
16	2420	5	On ½ hour	Moderately active	0.8
17	2100	5	On ½ hour	Distinctly active	6.7
18	2100	5	On ½ hour	Moderately active	15.3

When these results are compared with those in the previous table, it is seen that the amount of fat in these lungs, as judged by the number of fat droplets per field, is distinctly less. The general average per field

in this series is 3.5 as compared with 8.0 in the earlier series, while the animals used here were somewhat larger, averaging 2320 grams as compared with 1985 grams. Leaving the rubber bandages on the legs during the entire experimental time almost completely prevented the entrance of fat droplets into the capillaries of the lungs.

This is of significance only in proving that the fat found in the lungs in these experiments has its origin almost solely in the injured limbs. When the Esmarch constrictors were left on 2½ hours and then removed, the amount of fat embolism which developed during the remaining 2½ hours, even if the animals were allowed to move freely, averaged 2.6 droplets per field, which in this numerical standard is only one third of the number found when no prophylactic measures were employed. During the experiment it was noticed the No. 9 was markedly active, so much so that it attracted especial attention. This may account, at least in part, for the greater fat-content of these lungs.

The next animal in the series was kept quiet with occasional doses of chloral hydrate, after the removal of the constrictors at the end of 2 hours. These combined preventive measures reduced the amount of fat in the lung capillaries almost to a minimum, the average being 0.5 droplet per field. The next two animals of the group, Nos. 11 and 12, were kept suspended in towels after the removal of the constrictors at the end of 2 hours. Moderately low averages were obtained in these cases, but not distinctly less than with the animals which were given their freedom following the removal of the bandages. As previously stated, this towel suspension is not a very effective means of keeping rabbits quiet.

An attempt was then made to see if the same beneficial effects could be obtained by the use of the constrictors for briefer periods, so that its use might be more applicable to the usual orthopedic operations. The rubber bandages were left on the legs of rabbits Nos. 13, 14 and 15 for one hour and then removed. Rabbit No. 13 remained distinctly quiet following the removal of the constrictors, while the other two animals were moderately active. The average obtained with these three animals is 3.6, or slightly less than half the number obtained in those cases in which no prophylactic measures were used.

The Esmarchs were left on the legs of the last three animals of this series only 30 minutes after the crushing of the tibias. In the lungs of No. 16, the number of fat droplets averaged less than one for each microscopic field although the animal did not remain distinctly quiet following recovery from the anæsthesia; the note recorded at the time of the experiment being "only moderately active." The same note was recorded also for No. 18, in the lungs of which there were found many times as much fat. This difference is seemingly not dependent solely upon the activity of the animals, even though they are of equal size.

The general average obtained for the three animals with which the constrictors were used for ½ hour is 7.6, or only slightly less than the average obtained when no preventive measures were used. This result is not surprising when it is recalled that the entrance of fat into the lung capillaries could be almost completely prevented by continued chloral hydrate anæsthesia, and that the animals here used rarely recovered from the anæsthesia during the first half hour after the operation. In these cases, therefore, the Esmarchs are removed before the animal begins to move about, previous to which time but little fat enters the lung capillaries as indicated by subsequent experiments.

In another series of rabbits, further observations were made on the effect of narcotic doses of chloral hydrate in preventing fat embolism. The experimental time was here varied from the usual five-hour period (Table III).

TABLE III

Rabbit	Weight Grams	Duration of Experiment Hours	Esmarch Constrictor	Condition of Animal	Average Number of Fat Droplets
13	1350	2½	Not used	Moved at will	8.1
14	2450	3	Not used	Moved at will	11.3
15	2650	3	Not used	Quiet with chloral	0.9
16	2900	3	Not used	Quiet with chloral	1.2
17	2550	3	On full time	Quiet with chloral	0.5
18	2450	10	Not used	Moved at will	3.2

The first two rabbits in this series seem to show that the fat droplets are as abundant in the lung capillaries at the end of 2½ and 3 hours as they are at the end of 5 hours. It is necessary to note this fact in order to be sure that the lessened amount of fat found in the lung capillaries when the Esmarch constrictors are used, is not due simply to the briefer period allowed for the collection of the fat in the capillaries. Rabbits Nos. 15 and 16 were kept quiet by occasional doses of chloral hydrate during the entire time of the experiment, no Esmarch constrictor being used with these animals. This proved just as effective as the use of the constrictors for the two-hour period. With the constrictors on during the full time as with No. 17, only a very slight amount of fat embolism would be expected. The result obtained with No. 18 indicates that the number of fat droplets in the lungs of these experimental animals is no greater, and is probably even less, at the end of 10 hours than it is with the briefer three- or five-hour periods. Sections from the kidneys and myocardium of this animal contained moderate amounts of embolic fat; the average of 10 fields from the capsule to the pelvis of the right kidney was 1.1 droplets per field, while 10 fields counted in the myocardium gave an average of 1.3 droplets. Apparently, with the ten-hour experimental period, a large part of the embolic fat passes through the pulmonary capillaries and is widely scattered through the greater circulation.

A comparison of the results obtained with the 7 rabbits which were allowed to move about freely, or were simply suspended in a towel, indicates that a fairly constant amount of pulmonary fat embolism is produced by crushing the tibias of rabbits and that a rough estimation of this amount, for comparative purposes, can be made by counting the fat droplets in many representative microscopic fields. The general average for these animals is 8.5 droplets per low power microscopic field, or when the small, half-grown rabbit No. 3 is omitted, the general average becomes 9.8. If the 6 rabbits are considered, in which cases the Esmarch constrictors were used for a period of 2 hours or 2½ hours, and then removed, the general average is found to be 1.9 fat droplets per microscopic field as compared with 8.5 when no attempt was made to prevent the entrance of fat into the blood stream.

The fact that only a small amount of fat was found in the lung capillaries of the two animals which were kept quiet with occasional doses of chloral hydrate, without any other precautions being taken, indicates that in these healthy animals, the trauma subsequent to the crushing of the bones is a larger factor in the production of fat embolism than is the crushing itself. The importance of these postoperative traumatisms is shown also in those animals with which the Esmarch constrictor was used. The rabbit which was most active, following the removal of the constrictors, is the one in which the greatest amount of fat embolism occurred; on the contrary, the one which was kept quiet with chloral hydrate, following the removal of the constrictors, had the least amount of all, except one on whose legs the constrictors were left during the entire experimental time.

FAT EMBOLISM PRODUCED BY THE ALBEE BONE TRANSPLANTATION OPERATION

Because of an occasional and unexplained death following the Albee bone transplantation operation in paralytic scoliosis and tuberculous spondylitis (Pott's disease) and because of a possible relationship between fat embolism and postoperative pneumonias, similar operations on animals were planned to determine the amount of fat embolism produced. Wolcott (21) states that out of the 198 operations of this kind performed by Dr. Albee previous to January 1, 1915, one child of 6 years died the day following the operation, probably from shock; another patient died of status lymphaticus and still another of pneumonia, one week after the operation. One fatality following this type of operation is reported by Ryerson (4) as in all probability due to fat embolism. This apparently is the only case reported to date, in which fat embolism was even suspected. If these operations when performed on experimental animals, produced even a moderate amount of fat embolism, a standard proce-

dure would then be available for subsequent testing of means of prophylaxis.

Methods and results. For these experiments, 18 rabbits and 7 dogs were used; all of which were allowed to live 5 hours after the completion of the operation. The rabbits were anæsthetized as in the earlier experiments; the dogs were similarly treated, except that 0.35 grams of chloral hydrate, per kilogram of body-weight, was given in solution by stomach instead of by rectum. An incision was made through the skin and underlying soft tissues, over the most superficial portion of the tibia and extending from one end of the bone to the other. By means of a motor saw, such as is now commonly used for this purpose, a splint of bone approximately 5 centimeters long and 0.3 to 0.5 centimeters wide, was removed from each tibia of the rabbits. This could be done with very little jarring or disturbance of the bone marrow. The skin incision was then carefully closed to prevent loss of blood. In the complete operation these tibial splints were then sutured into a cleft made by splitting the spinous processes of six vertebræ in the lower dorsal and upper lumbar region. This attempted splitting of the narrow spinous processes was not always successful but the amount of trauma to which they were subjected was equalized as nearly as possible.

To determine the amount of fat embolism produced in rabbits by removal of the tibial splints alone, a narrow strip of bone was removed by means of a motor saw from each of the tibias of 4 rabbits. No attempt was made here to produce any unnecessary injury to the bone marrow. A subsequent examination of the lungs revealed only a very limited amount of fat in the capillaries. The general average of the number of fat droplets per low power microscopic field was 0.35, or one fat droplet for three fields. The average in the different animals ranged from 0.1 to 0.6, but this largest amount can be accounted for, in part, differently, since the animal from which these lungs came fractured a leg soon after the operation. It is seen, therefore, that this slight injury to the bones in the removal of splints from the tibias, produces an appreciable but not a large amount of pulmonary fat embolism in rabbits. Table IV shows the results obtained with the different animals.

TABLE IV

Rabbit	Weight Grams	Operation Performed	Average Number of Fat Droplets per Field
19	2350	Splints from tibias	0.4
20	2150	Splints from tibias	*0.6
21	2500	Splints from tibias	0.3
22	2200	Splints from tibias	0.1

* Leg broken.

To see if any fat could be found in the lung capillaries following injuries to the subcutaneous fatty tissues and the trauma due to the splitting of the spinous processes, the spinal part only, of the Albee operation, was performed on 4 rabbits. The incision over the spinous processes was made sufficiently long to give access to six vertebræ in the lower dorsal and upper lumbar region, and the processes were then split with a chisel. The amount of fat embolism produced, as judged by the number of the fat droplets in the capillaries of the lungs, is distinctly greater than that produced by the removal of the tibial splints. The average for the two animals which survived the operation is 1.6 droplets per field as compared with a general average of 0.35 in the earlier series. Two of the 4 rabbits in this group died just before the completion of the operation. The tissues from these animals were preserved in the usual way and the lungs later examined for their fat-content. Even in the brief time that the animals lived, after the beginning of the operation, a considerable amount of fat embolism had developed, the average for the two being 0.75 fat droplet per field. Nothing was found to account for the death of these animals; but, it might be due to mechanical interference with respiration, since they were placed on their bellies during the splitting of the spinous processes. The individual results are shown in the Table V.

TABLE V

Rabbit	Weight Grams	Operation Performed	Average Number of Fat Droplets	Remarks
23	1900	Spinal part only	0.4	Died during operation
24	2300	Spinal part only	1.7	Killed at end of 5 hours
25	2700	Spinal part only	1.5	Killed at end of 5 hours
26	1900	Spinal part only	1.1	Died during operation

Complete Albee operations, including both the removal of the tibial splints and the splitting of the spinous processes, were then performed on 4 rabbits with results as shown in Table VI.

TABLE VI

Rabbit	Weight Grams	Operation Performed	Average Number of Fat Droplets per Field
27	2500	Complete Albee	1.3
28	2450	Complete Albee	1.7
29	2550	Complete Albee	1.7
30	2200	Complete Albee	1.6

The general average of the number of fat droplets per microscopic field is here again 1.6, or exactly the same number obtained when only the spinal part of the operation was done. The latter, however, was the general average from only two pairs of lungs and the apparent error is not great, since the general average obtained from the tibial part of the operation is only 0.35 per field.

Since the amount of fat embolism produced by the removal of the tibial splints was entirely inadequate for use in connection with preventive measures, an attempt was made to obtain a larger, and yet fairly constant amount, by breaking up the marrow of the tibias, after the removal of the strips of bone. Esmarch constrictors were used with 4 of these rabbits to produce bloodless fields; in two cases the rubber bandages were left on during the entire operation, being removed immediately after the wound had been closed with sutures; while in the remaining two cases, the constrictors were removed before the wound was sewed up, thus giving some opportunity for the escape of the fat-containing blood. The irregularities in the results obtained in this series of animals baffle all attempts at interpretation. The results are given in Table VII.

TABLE VII

Rabbit	Weight Grams	Operation Performed	Esmarch Constrictor	Average Number of Fat Droplets
31	2050	Splints removed and marrow broken up	Not used	0.8
32	2950		Not used	2.8
33	2850		During entire operation	8.1
34	2350		During entire operation	2.1
35	2650		Removed before sewing up	3.1
36	2500		Removed before sewing up	7.7

Fat embolism produced by the Albee operation when performed on dogs. Because of the small amount of fat embolism produced in rabbits by the unmodified Albee operation, it was decided to perform similar operations on dogs. For this purpose, 7 large, mature, and moderately well-nourished dogs were used. Table VIII shows the operations performed and the results obtained.

TABLE VIII

Dog	Weight Kilograms	Operation Performed	Remarks	Average Number of Fat Droplets
1	15.5	Splints from tibias	Marrow broken up	2.5
2	16.5	Complete Albee	Marrow broken up	1.6
3	17.8	Complete Albee	Marrow not disturbed	0.1
4	17.0	Complete Albee	Splints removed with chisel	0.5
5	17.0	Complete Albee	Splints removed with chisel	0.1
6	22.0	Complete Albee	Splints removed with chisel	0.2
7	14.0	Complete Albee	Splints removed with chisel	0.5

When the bone marrow of the tibias was broken up with a probe as with dogs 1 and 2, a moderate but seemingly inconstant amount of pulmonary fat embolism was produced. With the unmodified Albee operation, the tibial splints being removed by means of a saw, the lungs of Dog 3 contained a minimum of free fat, averaging only one droplet for 10 microscopic fields. It was, therefore, apparent that the Albee operation liberates too little fat from the bone marrow of normal dogs, to be used for the testing of prophylactic measures.

Because of the commonly accepted view that the use of the chisel in certain bone operations increases the danger of fat embolism, complete Albee operations were performed on 4 dogs, the tibial splints being removed by means of a chisel. In these operations a comparatively dull chisel was used, and an effort was made to produce as much jarring of the bone as could reasonably accompany the removal of such splints from the healthy tibias of dogs. The results obtained from a subsequent examination of the lungs of these dogs for intracapillary fat, as shown in the above table, gave a general average of only 0.33 droplet per field, or only one droplet for three microscopic fields. This seems to show quite conclusively that the use of the chisel in the removal of splints from the healthy bones of dogs does not increase very appre-

ciably the amount of fat embolism produced, above that produced when the motor saw is used.

DISCUSSION OF RESULTS

The fairly constant numerical values obtained by counting the fat droplets in the lung capillaries, following the crushing of the tibias of normal mature rabbits, is evidence that this procedure when unrestricted gives rise to comparable amounts of fat embolism.

Furthermore, any marked decrease in this numerical value, as observed in a series of animals, can be interpreted as indicating a smaller amount of pulmonary fat embolism. With this as a standard, it is possible to compare the amounts of fat liberated by different operative measures. The striking of the otherwise uninjured tibias is thus seen to produce a very slight amount of fat embolism as compared with the crushing of these bones. Likewise, the destruction of the bone marrow as completely as possible by means of wires introduced into the marrow cavities through holes at the ends of the bones, or the breaking up of the marrow with a probe, after the removal of splints from the tibias, produces a much smaller amount of fat embolism than does the crushing of the tibias. That the latter causes a larger amount of fat to enter the blood-vessels may be due in part to the greater injury to the fat-containing tissues, but it is probably due largely to the greater interference with the clotting of the blood, or rather the disturbance of the clots by the postoperative activities of the animals; the trauma in these cases is exerted on the injured tissues which are no longer protected by intact bone. In support of this is the result obtained when the animals are kept quiet with chloral, following the crushing of the tibias; no greater amount of fat was found in the pulmonary capillaries of these than was found in others when the marrow was broken up and the bony framework left intact as a support for the injured marrow.

That Esmarch constrictors when left on the legs of rabbits for 2 hours after the crushing of the tibias, distinctly lessen the amount of fat entering the circulation during the remainder of the experimental period, seems apparent from the data here presented. This preventive action may, indeed, be due, as suggested by Buerger, to the earlier and firmer clotting of the stagnant blood, a part of the free fat being retained in the clot and the torn vessels being occluded by thrombi. The fact that activity on the part of the animal, following the removal of the constrictors, may offset to some extent the advantage gained by their use, shows that even after clotting has occurred, trauma to the injured limbs may still cause the entrance of some fat into the blood stream, and emphasizes the importance of early and complete fixation in those cases in which there is danger of fat embolism. The use of the Esmarch constrictors for periods of 30 minutes or even one hour after the operation, furnishes only a slight or uncertain protection against the subsequent development of pulmonary fat embolism in rabbits which are allowed to move about freely after the removal of these constrictors. Those animals which remain distinctly quiet during the whole experimental period will usually have relatively few fat droplets in their lung capillaries, but this will usually be true as well when the constrictors have not been employed at all. If coagulation of the blood in the injured area is an important factor in preventing the entrance of fat into the blood stream, as is here indicated, it is suggested to us by Dr. Wells that applications or injections of kephalin or brain lipoids (22) made at the site of operation, might hasten the clotting of the blood as discovered by Howell (23), and thus lessen the time necessary for the use of the constrictors.

CONCLUSIONS

1. Crushing the tibias of mature rabbits produces a moderate and fairly constant amount of fat embolism, as determined by counting the fat droplets in a large number of representative microscopic fields, in stained sections of lung tissue.

2. Esmarch constrictors placed on the legs of rabbits, previous to the crushing of the tibias and removed after two hours, lessen distinctly the amount of fat entering the lungs during the remainder of the experi-

mental period; this effect is much less marked and more uncertain when they are removed at the end of a half hour or even one hour.

3. The amount of fat embolism which develops after the removal of the constrictors is dependent largely upon the activity of the animals.

4. Rabbits kept in chloral hydrate narcosis during the entire experimental period, following the crushing of the tibias, develop only a small amount of fat embolism although the constrictors are not used.

5. The removal, by means of a motor saw, of splints from the tibias of normal dogs and rabbits produces an appreciable but a very small amount of pulmonary fat embolism.

6. The use of the chisel for the removal of the tibial splints from dogs increases very slightly, if at all, the amount of fat entering the circulation.

7. The spinal part of the Albee bone transplantation operation, on normal rabbits, produces more fat embolism than does the tibial part.

We wish to express our indebtedness to Dr. H. Gideon Wells for his helpful direction of this work and to Dr. E. W. Ryerson for suggesting the problem and for furnishing the motor saw used in these experiments.

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SEROUS MENINGITIS FOLLOWING TRAUMATISM[1]

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THE fact that a serous meningitis without any other complicating injury to the brain, following an injury to the head, could cause death unexpectedly came to my attention in the year 1903.

A man fell forty feet from a coal dock and was picked up unconscious with a compound fracture of the right wrist. He remained unconscious only a few minutes; was removed to a hospital; the fracture was operated on under an anæsthetic and for five days the man was apparently normal. On the sixth day he began to have headache and this was followed by a progressive right hemiplegia, which was complete on the ninth day, when I first saw him in consultation. Believing that he had probably fractured his skull on the left side and that a hæmorrhage was taking place from the posterior branch of the middle meningeal artery, I advised an operation to remove the blood-clot. This was declined.

The following day the man became totally unconscious and when he was in a state of coma permission was given to operate. I trephined the skull over the middle fosa and found no clot. Upon opening the dura, the cortex of the brain presented an ecchymotic appearance. No cerebrospinal fluid appeared. I passed a grooved director between the dura and brain and a few drops of cerebrospinal fluid escaped. In a few minutes the flow increased to a small stream. At the end of fifteen minutes the patient began to show signs of life. The breathing improved. The operation was performed without an anæsthetic. A drain was inserted beneath the brain and the wound closed. The man made an uneventful recovery and is still living.

A review of the literature of the surgery of the brain will give but little information on traumatic serous meningitis. The pathol-

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ogy deals almost entirely with cysts, the result of hæmorrhage. It is recognized that fracture of the skull is not a necessary factor, as the elasticity of the cranium will permit of trauma to the contents of the skull. There is no doubt that cases similar to the one reported have been seen from time to time and they may be reported in the literature, but if so, they have escaped my attention.

For years this case has been in my mind. In the examination of head injuries with marked symptoms of cerebral compression, hæmorrhage is usually considered. For a long time it has been my custom to bear in mind also the possibility of a simple, serous effusion, especially when no focal symptoms are present. Within an hour following a serious contusion of the membranes of the brain, fatal compression of the brain can occur from a serous meningitis without hæmorrhage, in fact, a valuable aid to the prognosis of recovery is the finding at the time of operation, of a free amount of cerebrospinal fluid.

Last summer I watched a moving picture illustrating the steps in a decompression operation, in which a young surgeon of considerable ability and enthusiasm was busily chipping away the skull. After a sufficient opening had been made to show a freely pulsating brain and a large amount of cerebrospinal fluid, I thought that were the surgeon familiar with the favorable prognosis the initial opening of the skull showed, he might have spared the patient some useful bone.

In reviewing the clinical history of serous meningitis cases, I am impressed by the fact, that as a rule there is no primary unconsciousness; a history of being momentarily stunned is about the extent of the complaint. The symptoms all of the patients complain of is a frontal headache of severe character. These two facts stand out prominently. The stage in which the case is first seen by the surgeon will show a group of symptoms that are characteristic of cerebral compression. Seldom have we found a choked disc. In every case, however, there has been noticed a tortuosity of the retinal veins.

If the operation is done within forty-eight hours of the accident, in nearly every case there will be found a free amount of fluid; provided of course, that the injury received did not cause hæmorrhage. I am prepared to say that many cases of serous meningitis following blows on the head are not recognized, because hæmorrhage has been considered only in the light of a causative factor, and we have not as yet learned to think in terms of serous meningitis. We have yet to learn that a simple contusion of the dura, uncomplicated by hæmorrhage, can produce the same condition. The unyielding, unbroken, calvarium furnishes the counter pressure for a hydraulic pressure, beneath which the delicate brain structure is compressed. The man who falls backward from a load of hay and does not fracture his spine; the man struck on the forehead with a fragment of a pulley from a revolving shaft; the man who slips backward on an icy pavement and strikes his head sufficiently hard, but not hard enough to cause hæmorrhage; the automobile accidents; the trolley accidents; the baseball accidents; the elevator accidents; the falls from ladders; these are the more familiar cases that have furnished material for this paper.

It would indeed be misleading to leave the inference that serous meningitis unaccompanied by hæmorrhage is found only in comparatively mild injuries to the skull. Such is not the case. Fracture of the skull may occur without hæmorrhage of the brain and without serous meningitis. The important fact to be kept in mind is that even with hæmorrhage, the accompanying œdema of the brain unrelieved by decompressive measures, may cause a fatal issue. The turning up of the dural flap in Cushing's decompression is the most important factor of the technique other than the opening of the dura itself.

The following case which is somewhat dramatic because of its legal aspect, illustrates what may follow a trivial insignificant injury to the head. More than a year has passed since the injury was received and since June of this year the man has been perfectly well and continuously employed.

In September, 1915, a young man of twenty with an unusually good family history, while work-

ing in a munition factory, was passing a press which was operated by a lever, not unlike a pump handle. As he passed under this lever it fell striking him on the crown of the head. He ducked his head with the remark, "Gee, but that hurt!" and then continued with his work. At suppertime that night he told his sister of the accident, saying that he had nearly been killed. The sister then forgot the incident for a period of thirteen weeks. The man continued at his work for six weeks and nothing unusual occurred during this period. He then began to complain of headache and said his eyes troubled him. He was sent to an oculist who made an appointment for him which he failed to keep. He began to show mental impairment and went from bad to worse, until at the end of thirteen weeks from the date of the injury he was absolutely demented. An alienist of more than average ability examined him and failing to get a history of an injury to the head, made a diagnosis of dementia præcox. Two other physicians appointed by the court examined him and recommended his commitment to the insane hospital. These papers were duly filed, but owing to the fact that it was a busy Saturday, the Judge did not sign the papers. The following day at breakfast the sister for the first time recalled the story of the accident and told it to her father. I was asked whether there could be any possible connection between the trifling accident and the present condition of dementia. The injury itself left no outward mark at the time it occurred. The scalp was not lacerated nor visibly contused, and there was no headache.

Having in mind the first case reported, it seemed altogether probable that the trivial accident had caused a serous meningitis and that the mental impairment was the result of interference with the circulation of the brain. On this theory I made a subtemporal decompression, evacuated four ounces of cerebrospinal fluid of ordinary appearance. I introduced a drain beneath the brain and closed the wound. During the succeeding days following the operation, there was a gradual return to consciousness and at the end of ten days the recovery was practically complete.

At my suggestion the patient wrote a postcard to my friend the alienist, telling him he was making a nice recovery and hoped that he would call and see him before he left. The alienist, who was present at the operation at my invitation, called me up the following day and asked how the man was getting along. In answer to the question as to whether he had received a postcard from him, he said: "Yes, but some one else wrote it for him." "No," said I, "he wrote it himself."

The case is reported thus fully, because there are in it elements of importance. It was unfortunate that the oculist, the man consulted, did not have time to examine him immediately. He surely would have seen tortuous veins in the fundus and would have prevented, by an early decompression, the subsequent insanity.

The case is noteworthy also, in showing that a blow which left no visible evidence and no immediate disability, could so contuse the membranes of the brain as to produce an extensive serous effusion. Until we know what the factors are which control the secretion of the cerebrospinal fluid and the pressure it exerts in the closed dural sac, we shall do well to recognize that it may cause serious and fatal pressure. All cases will not react alike. There are some cases, however, which show a predisposition to meningeal irritation and these must be differentiated and early relieved by decompressive measures.

STUDIES IN CLINICO-PATHOLOGIC STANDARDIZATION AND EFFICIENCY[1]

I. LEGITIMATE ACTUAL ERROR IN DIAGNOSIS OF MAMMARY CONDITIONS

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A COMPARATIVE examination of the clinical and pathological diagnoses in the following series of 1800 mammary pathological conditions operated upon in this clinic reveals certain items in medical efficiency of value from several standpoints.

NUMBER OF PATHOLOGICAL DIAGNOSIS

Clinical Diagnosis	Carcinoma	Fibro-adenoma	Intracanalicular Fibro-adenoma	Chronic Mastitis	Cyst	Total
Carcinoma	722	7	0	27	7	763
Epithelioma	2	0	0	0	0	2
Carcinoma?	90	12	0	38	17	157
Sarcoma?	3	0	0	1	0	4
Sarcoma	1	1	0	0	1	3
Adenoma	10	34	10	25	9	88
Fibro-adenoma	5	58	9	3	4	79
Intracanalicular fibroma	0	0	3	0	0	3
Fibroma	0	10	10	4	0	24
Cyst adenoma	0	3	1	1	0	5
Tumor	44	83	31	88	49	295
Benign	6	15	0	5	4	30
Benign?	2	0	0	2	2	6
Nodules	1	3	1	3	0	8
Cyst	6	9	0	10	12	37
Cyst?	0	0	0	0	3	3
Chronic mastitis	9	24	10	139	8	190
Chronic mastitis?	1	0	0	3	0	4
Papilloma	0	0	0	1	0	1
Ulcer	1	0	0	0	0	1
Tuberculosis	2	0	0	0	0	2
Abscess	2	0	0	0	0	2
Myxoma	0	0	0	0	1	1
No diagnosis	26	35	1	26	4	92
Total	933	294	76	376	121	1800

This table presents the following detailed facts.

PERCENTAGE OF ACTUAL ERROR

	Total Number	Percentage
Mammary carcinomata diagnosed in the surgical laboratory	933	
Mammary carcinomata diagnosed benign by the clinician	41	4
Mammary carcinomata not positively diagnosed by clinicians	170	18
Clinical diagnoses of carcinoma in series	763	
Clinical diagnoses of carcinoma which were incorrect	41	5
Chronic mastitides diagnosed in the surgical laboratory	376	
Chronic mastitides diagnosed a malignant condition by the clinician	28	7
Clinical diagnoses of chronic mastitis which were incorrect	51	26
Clinical diagnoses of chronic mastitis which were carcinoma	9	4
Fibro-epithelial neoplasms diagnosed in surgical laboratory	370	
Fibro-epithelial neoplasms diagnosed a malignant condition	8	2
Clinical diagnoses of fibro-epithelial neoplasms	200	
Clinical diagnoses of fibro-epithelial neoplasms which were a malignant condition	15	7
Cysts diagnosed in the surgical laboratory	121	
Cysts diagnosed carcinoma or sarcoma by clinician	8	6
Clinical diagnoses of cyst	37	
Clinical diagnoses of cyst which were carcinoma	6	16
Clinical diagnoses of adenoma	88	
Clinical diagnoses of adenoma which were carcinoma	10	11
Clinical diagnoses of fibro-adenoma	79	
Clinical diagnoses of fibro-adenoma which were carcinoma	5	6
Clinical diagnoses of benign	30	
Clinical diagnoses of benign which were carcinoma	6	20

The actual error consists of a clinical diagnosis of a malignant condition when a benign condition really exists or vice versa. In these errors the indicated operation would be either too radical or not radical enough; the patient would be a victim of too little or too much surgery. Such actual error from a clinical diagnostic standpoint is certainly inevitable and unavoidable from the nature of the pathologic conditions involved, especially since it is a physical impossibility always to differentiate benign from malignant conditions by any known clinical methods. The nature of certain advanced pathologic conditions in the breast are very evident to the experienced clinician, but that there are conditions the diagnoses of which are certainly not evident is clearly revealed in the table presented above. These uncertain conditions are apparently more numerous than the ordinary professional impression seems to convey.

Legitimate as the error is from the standpoint of the insufficiency of signs, symptoms, and clinical history, it is absolutely illegitimate when viewed from the standpoint of surgical pathologists who unfortunately are painfully inadequate in quality and quantity in the hospitals of this and other countries.

In the past this inadequacy was unavoidable on account of a lack of operative surgery in early pathologic conditions, the small number of pathologists to study early malignant conditions in association with inflammatory lesions and the scarcity of pathologists as a result of the rush of laboratory men into

[1] A series of four papers read before the Academy of Medicine, Scranton, Pennsylvania, October 10, 1916; Montour County Medical Society, Danville, Pennsylvania, October 20, 1916; and the Southern Minnesota Medical Society, December 5, 1916.

the fields of immunology, serology, and bacteriology, and lastly, the inadequacy of monetary and moral compensation sufficiently great to allow constructive, energetic men of vision to spend their lives in this branch of medicine.

Recent years have somewhat altered these circumstances. Surgeons by their own initiative and perfection of surgical technique have opened a new field for the pathologist who happens to be especially interested in the immediate clinical aspect of efficiency in therapeutics and fresh tissue research. This field presents methods which give to the surgeon during operations the same type of service which range-finders give artillerymen in battle. During operative procedure accurate gross and microscopic diagnoses may be given to the operator in from fifteen seconds to three minutes during which time no operation can be completed and no extra material risk is added to the duration of the anæsthesia.

In one organ alone, i.e., the breast, one may see efficiency in one item which in itself is positive proof of the valuable service rendered by the modern fresh tissue surgical pathologist. This item consists of the fact that out of 933 mammary carcinomata the surgical pathologist discovered during operation 211 (22 per cent) carcinomata which the clinician and surgeon had diagnosed benign or doubtful conditions. Only positively recorded clinical diagnoses are included in this number.

The practical surgeon today, however, is beginning to learn that clinical diagnoses in the breast are frequently not positive. When the surgical pathologist picks up 22 per cent of the total mammary carcinomata by means of his special training and methods he renders a service of supreme value not only to the surgeon but to the patient.

The question which arises from these facts is: Can surgical work be done on this organ efficiently and justly without such assistance? The answer is evident in the figures presented in this paper and one strongly suspects that what has been termed the legitimate error becomes an illegitimate error without such assistance. This statement may appear to be too radical in view of the fact that enough men, especially trained in surgical pathologic diagnosis, are not available to supply all of the hospitals. This does not alter, however, the truth relative to surgical and clinical efficiency.

An extensive and wordy dissertation upon this question could not emphasize this truth to any greater advantage than the figures themselves.

II. THE APPARENT ERROR IN THE DIAGNOSIS OF MAMMARY CONDITIONS

In the first article of this series a comparative analysis of the clinical and pathological diagnoses of 1800 operative pathologic mammary conditions was made from the standpoint of the legitimate actual error in clinical diagnoses. It was pointed out that while there is a definite clinical error dependent upon inadequacy of clinical methods this legitimate error becomes illegitimate from the standpoint of justice to the patient simply because such error might be avoided by the utilization of properly trained surgical pathologists in immediate conjunction with operative procedure.

While the apparent error is not of such serious moment to the patient, it occurs in a much higher percentage of clinical diagnoses than does the actual error. It consists of calling a benign condition by the name of another benign condition or a malignant condition by the name of some other malignant condition. In neither case would the error in nomenclature change the operative procedure and, therefore, would not cause the patient to undergo any unnecessary radical or insufficient treatment. It is of interest and importance only from the standpoint of efficiency of nomenclature in the transference of thought from one scientific individual to another.

Any business or military code with an error of from 8 to 50 per cent would not be tolerated and still the medical profession, which is

striving for scientific efficiency, utilizes such a code. The following figures represent the facts for one organ; i.e., the mammary gland:

	Total Number	Percentage
Chronic mastitides diagnosed in the surgical laboratory	376	
Chronic mastitides diagnosed fibro-epithelial neoplasm	33	8
Clinical diagnoses of chronic mastitis	190	
Clinical diagnoses of chronic mastitis which were fibro-epithelial neoplasms	34	17
Fibro-epithelial neoplasms diagnosed in the surgical laboratory	370	
Fibro-epithelial neoplasms diagnosed chronic mastitis	34	9
Fibro-epithelial neoplasms diagnosed some other benign condition	32	8
Cysts diagnosed in the surgical laboratory	121	
Cysts diagnosed in fibro-epithelial neoplasms	14	11
Clinical diagnoses of cyst	37	
Clinical diagnoses of cyst which were fibro-epithelial neoplasms	9	24
Clinical diagnoses of cyst which were chronic mastitis	10	27
Clinical diagnoses of adenoma	88	
Clinical diagnoses of adenoma which were chronic mastitis	25	28
Clinical diagnosis of adenoma which were fibro-epithelial neoplasms	44	50

In this series the following nomenclature was utilized by the clinicians.

[1] Adenoma	Growth
[1] Adenofibroma	Lipoma
Lipoma	Lump
Benign	Myxoma
Cyst	Mass
[1] Carcinoma	Malignant
Chronic mastitis	Nodule
[1] Cystic fibro-adenoma	[1] Neuroma
[1] Cyst adenoma	No diagnosis
Cystic degeneration	Papilloma
[1] Fibroma	Placque
[1] Fibro-adenoma	Retention cyst
Sarcoma	Sebaceous cyst
[1] Fibro-myxoma	

[1] Purely pathologic terms utilized by the clinician.

These names were applied to the following pathologic conditions:

Adenofibroma	[1] Fibromyoma
Adenoma	[1] Fibrocystadenoma
[1] Adenomyxofibroma	[1] Fibromyxo-adenoma
[1] Angioma	[1] Intracanalicular myxoma
[1] Andenofibromyxoma	[1] Intracanalicular fibroma
[1] Adenomyxoma	[1] Intracanalicular fibro-adenoma
Benign	[1] Intracanalicular adenofibroma
Cyst	[1] Intracanalicular papilloma
[1] Cystic fibroma	[1] Intracanalicular fibromyxoma
Cystadenoma	[1] Intracystic papilloma
[1] Chondrolipofibroma	[1] Intracanalicular myxofibroma
Cystic fibro-adenoma	[1]Intraductal papilloma
Cystic adenofibroma	[1]Intracanalicular adenomyxoma
[1] Calcareous tumor	[1] Intracanalicular fibro-adeno-myxoma
Chronic mastitis	[1] Intracanalicular papilloma (malignant)
[1] Cystic intracanalicular papillary adenofibroma	Lipoma
[1] Calcareous adenoma	[1] Myxofibroma
[1] Cystic calcareous fibroma	[1] Myxofibro-adenoma
[1] Calcareous intracanalicular adenofibroma	Myxoma
Carcinoma	[1] Myxo-adenofibroma
[1] Dermoid	[1] Papillary cyst
[1] Embryoma	[1] Papillary fibro-adenoma
Fibro-adenoma	[1] Papillary fibrocystadenoma
Fibroma	[1] Pericanalicular fibroma
Fibromyxoma	Sebaceous cyst.
[1] Fibrolipoma	

[1] Pathologic terms not utilized by the clinician.

In utilizing this nomenclature the following errors were made.

Pathologic Diagnosis	Clinical Diagnosis
Diffuse lipoma	called chronic mastitis
Cyst	called fibro-adenoma
Fibro-adenoma	called adenoma
Fibro-myxoma	called carcinoma
Adenofibroma	called fibro-adenoma
Fibro-adenoma	called retention cyst
Fibro-adenoma	called adenofibroma
Adenofibroma	called carcinoma
Fibroadenoma	called fibroma
Cystic fibro-adenoma	called myxoma
Andenofibroma	called chronic mastitis
Cystic fibro-adenoma	called chronic mastitis
Cysts	called carcinoma
Cysts	called chronic mastitis
Fibro-adenoma	called chronic mastitis
Intracanalicular fibroma	called carcinoma
Lipoma	called cyst
Papillary fibrocystadenoma	called cystadenoma
Cyst	called adenoma (early carcinoma)
Fibro-adenoma	called cystadenoma
Cystadenoma	called adenoma
Adenofibroma	called fibroma
Intracanalicular papilloma	called chronic mastitis
Intracanalicular fibro-adenoma	called fibroma
Fibrolipoma	called chronic mastitis
Intracanalicular fibro-adenoma	called adenoma
Adenofibroma	called cystadenoma
Fibrocystadenoma	called adenoma
Intracanalicular fibro-adenoma	called fibro-adenoma
Intracanalicular fibro-adenoma	called chronic mastitis
Myxoma	called neuroma
Intracanalicular adenofibroma	called fibroma
Cyst	called adenoma
Adenomyxoma	called adenoma
Lipoma	called fibroma

These facts, vivid as they are, mean something to an analytical mind which is dealing with scientific efficiency and from them the following generalization may be logically made: The medical profession is trying to adapt detailed pathologic nomenclature and terminology to conditions which do not always reveal their detailed characteristics through signs and symptoms. This usage on the part of clinicians has been the logical outcome of the natural evolution of our knowledge of medicine, but the evolution should not stop at this stage. Efficiency demands, at least, an attempt at correction.

Experience with this series of cases has taught that the clinicians and surgeons really desire certain fundamental facts in so far as the patient is concerned; they want to know whether the condition is benign or malignant and whether it is operable or inoperable. These are the essential factors which the practical surgical pathologist must face with the clinicians and surgeons. Detailed names play a very small rôle in the rendition of his assistance in such conditions.

It has been urged by some surgeons who have had some training in pathology, that

they should be able to make their own gross diagnoses. This is ideal and possible if surgeons would spend time enough in learning pathology. Six months, a year or five years of training in gross pathology will not keep a surgeon from making a high percentage of error in gross diagnoses.[1] It must be fully realized by the medical profession that in many conditions a microscopic diagnosis is absolutely necessary. This requires special training and experience far beyond that which can be obtained in the regular medical course or during internship in a laboratory or perhaps a course abroad.

Nomenclature and classifications which have been made by excellent surgeons, who were poor pathologists, have been largely responsible for much of the chaos in clinical pathology. Synonyms and classifications are almost as numerous as textbooks. There are apparently no signs, symptoms, and clinical histories which will positively differentiate any of the following conditions: adenoma, adenofibroma, cystic-fibro-adenoma, cystadenoma, fibroma, fibro-adenoma, myxoma, lipochondrofibroma and fibromyxoma. And still the clinicians and surgeons continue to utilize such terms in spite of their cognizance that the clinical differential diagnosis is impossible by any known methods.

The clinicians in this series of cases have automatically shown evidence of the inefficiency of such usage and have substituted in their practice, during recent years, the terms benign, tumor, growth, lump, nodule, and mass. To them these terms are practically synonymous and do not describe a detailed microscopic condition which they cannot see. This is a hopeful sign for scientific efficiency in medicine.

In this series of cases the clinicians refrained from using such terms as

Intracanalicular—
Myxoma,
Fibroma,
Fibro-adenoma,
Adenofibroma,
Papilloma,
Fibromyxoma,
Adenomyxoma.

These neoplasms, however, form a group which constitutes a much higher percentage of benign solid tumors of the breast than do the fibromata, adenomata, adenofibromata, fibro-adenomata, cystadenomata, myxomata and fibromyxomata, terms with which the clinician is perhaps much more familiar.

The percentage of error in terminology is greatest in the benign group of conditions. From a standpoint of clinical efficiency these mistakes represent only an apparent error and certainly do not reflect upon the clinician's ability to render scientific service to his patients.

The names sound well, but what is needed and demanded today is clear, concise, accurate and simple scientific medical practice which can be expressed in a clear, concise, accurate and simple scientific clinico-pathologic terminology and nomenclature.

[1] In a series of consecutive examinations of 1582, surgical specimens by the writers, it was absolutely necessary to make microscopic diagnoses in 29.3 per cent.

III. THE AVOIDED ERROR IN THE DIAGNOSIS OF MAMMARY CONDITIONS

In the first two papers of this series the legitimate and apparent errors in clinical diagnosis of 1800 mammary pathologic specimens were considered. It was pointed out that the legitimate error becomes an illegitimate error when surgery of the breast is not accompanied by the immediate assistance of microscopic diagnosis and that the apparent error, while of no great importance from the patient's standpoint, is a result of a clinically inefficient pathologic nomenclature.

The third type of error in this series has been called the "avoided error" by which term is meant that error which did not occur simply because the clinician utilized some doubtful or non-specific nomenclature such as carcinoma? benign? malignant? chronic mastitis? cyst? sarcoma? tumor, nodule, growth, mass and no diagnosis and left the

actual diagnosis for the surgical pathologist to make.

The frequency of such a clinical habit may be seen in the following percentages:

	Total Number	Percentage
Mammary carcinoma diagnosed in the surgical laboratory	933	
Mammary carcinoma diagnosed a possible malignant condition	96	10
Clinical diagnoses of carcinoma?	157	
Clinical diagnoses of carcinoma? which were benign	67	42
Clinical diagnoses of carcinoma? which were malignant	90	57
Chronic mastitides diagnosed in the surgical laboratory	376	
Chronic mastitides diagnosed a possible malignant condition	44	11
Chronic mastitides diagnosed "no diagnosis"	26	6
Chronic mastitides diagnosed "tumor"	88	23
Chronic mastitides diagnosed a possible malignant condition, tumor, nodule or no diagnosis	161	42
Fibro-epithelial neoplasms diagnosed in the surgical laboratory	370	
Fibro-epithelial neoplasms diagnosed a possible malignant condition	12	3
Fibro-epithelial neoplasms diagnosed "no diagnosis"	36	9
Fibro-epithelial neoplasms diagnosed "tumor"	114	30
Cysts diagnosed in the surgical laboratory	121	
Cysts diagnosed "tumor"	49	40
Cysts diagnosed carcinoma?	17	14
Cysts diagnosed benign?	2	1
Cysts diagnosed no diagnosis	4	3
Clinical diagnoses of "tumor"	295	
Clinical diagnoses of "tumor" which were a malignant condition	44	14
Clinical diagnoses of "tumor" which were a benign condition	251	86

Perhaps the most interesting feature in this group of errors is the fact that 42 per cent of the clinical diagnoses of "carcinoma?" were actually benign.

Another interesting and important feature is the apparent realization on the part of the clinician that absolute diagnoses in the breast are not possible in a great many cases.

This realization may be seen in the frequency of avoided errors which consist of "carcinomata?" 157, "sarcoma?" 4, "tumor" 295, "benign?" 6, "nodule" 8, "cyst?" 3, "chronic mastitis?" 4, and "no diagnosis" 92, a total of 569 or 31 per cent of all diagnoses. Those figures certainly show a simple truth, i.e., that the present pathologic nomenclature is quite inefficient from a clinical standpoint and suggests the necessity of a more adequate nomenclature.

IV. CLINICO-PATHOLOGIC NOMENCLATURE OF MAMMARY CONDITIONS

In the first three papers of this series it has been clearly shown that an analysis of 1800 mammary pathologic conditions from the comparative standpoint of clinical and pathologic diagnoses reveals certain diagnostic errors which prove at least three definite things:

1. A legitimate actual error (1) of from 2 to 26 per cent.

2. An apparent error (2) of from 8 to 50 per cent.

3. An avoided error (3) of from 1 to 57 percent.

Coincidently with the determination of these percentages it was shown that 31 per cent of the clinical diagnoses of mammary conditions were made with a full recognition on the part of the clinician that a positive diagnosis could not be made. It was also shown that the actual or so-called legitimate error becomes an illegitimate error if not checked during operations by the immediate services of a well-trained surgical pathologist.

The apparent and avoided errors signified one essential fact, i.e., that the present pathologic nomenclature was inadequate, inefficient and unscientific when utilized for clinical diagnoses.

In view of these facts and the necessity for greater efficiency a simple clinico-pathologic nomenclature has been utilized successfully by the writer.

For the sake of convenience all pathologic conditions in the breast may be divided into encapsulated and non-encapsulated (diffuse) conditions, the history of which is dependent upon the reaction of the component tissues of the breast regardless of the irritative or destructive agencies.

It has been shown in the breast and other organs that the aggregations of specialized and differentiated cells which we call tissues react to irritation in certain ways. Under certain conditions the tissue cells are rapidly or gradually destroyed and there is a successful or unsuccessful attempt on the part of nature at their replacement or regeneration. The success of this attempt means healing, and the unsuccessful gradual attempt is associated with the following histological pictures dependent upon the quality, quantity, and duration of action of the destructive agent:

1. Primary cytoplasia when the differentiated tissue cells are present plus an hypertrophy of the regenerative cells of the tissues.

2. Secondary cytoplasia when the differentiated cells have partially or completely disappeared plus an hyperplasia of the regenerative cells.

3. Tertiary cytoplasia when the hyperplastic regenerative cells have migrated into the surrounding stroma (4).

An unsuccessful attempt at replacement and regeneration in the presence of any acute, virulent destruction such as pyogenic infections results in abscess or necrosis and destruction of the whole organism. An unsuccessful attempt at replacement and regeneration in the presence of chronic non-virulent tissue destruction results in a neoplastic hyperplasia of the regenerative cells of one or more of the tissues without their complete differentiation into tissues, or the eventual destruction of the whole organism. It is this neoplastic hyperplasia with or without subsequent differentiation into tissues which is of importance in chronic mastitis, and benign and malignant new-growths.

It is self-evident that a new-growth of cells benign or malignant must grow from something and that the cells of any tissue which is capable of growth are the regenerative cells. In the epithelial tissue of the breast these lie between the columnar or cuboidal secretory cells and the stroma. In the connective tissue the regenerative cells are the fibroblasts. In the presence of a chronic destruction of either or both of these special tissues there is an hypertrophy of the regenerative cells. This hypertrophy is often associated with or followed by hyperplasia and sometimes by migration.

In the condition of hypertrophy there is no evidence which warrants a suggestion of clinical malignancy because practically all chronic mastitides present this picture and every clinician and pathologist knows that all chronic mastitides are not associated with either benign or malignant neoplasms.

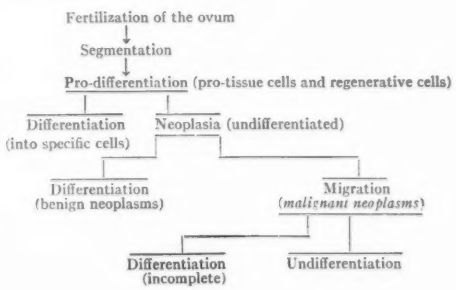
In the condition of hyperplasia of the regenerative cells the problem of malignancy or benignancy becomes more difficult because the hyperplastic regenerative cells are frequently morphologically identical with malignant cells but are still within the normal bounds of their specific tissues (5).

Who is there who has the power to say whether these growing cells will be brought back to their normal power of differentiation by means of normal tissue control or continue to grow and migrate into neighboring and distant tissues and become malignant?

In so far as the clinician, pathologist, and patient are concerned this is an indeterminate condition which definitely forms a histological line of demarcation between that which is definitely benign and that which is malignant.

The biological history of the evolution of these regenerative cells may be shown in the accompanying diagram, in which there is represented segmentation of the fertilized ovum and the production of cells which either produce, immediately, the tissues or the regenerative cells which later become differentiated into tissues. When the cells which are produced in this stage of pro-differentiation become differentiated in the normal course of embryologic development, normal tissues and a normal organism result.

It has been shown that in adult life the regenerative cells which occur in the stage of pro-differentiation in the postnatal organism do sometimes become hyperplastic (secondary cytoplasia); that they produce new-growths in which the tissues are differentiated and that they sometimes produce new-growths which consist of undifferentiated migratory cells. The new-growths with differentiation constitute the benign neoplasms. The new-growths with migration and incomplete differentiation constitute the malignant neoplasms.



These facts are true not only of epithelial tissue but also of connective or fibrous tissue and perhaps all tissues. In benign fibro-epithelial neoplasms the condition of secondary and tertiary cytoplasia also sometimes occurs, hence the presence of malignant conditions arising in the so-called fibro-epithelial neoplasms which are usually benign. In so far as the reaction of the tissues of the breast is concerned, it matters not whether they are encapsulated or non-encapsulated they react in these three degrees to chronic destruction. Upon the degree of reaction will depend the life history of the breast and consequently the whole body of which the breast is a part. Biologically in these three stages, we have cellular destruction, cellular hypertrophy, cellular hyperplasia, and cellular migration.

The regenerative cells possess certain possibilities. They reproduce specialized differentiated tissue cells, they reproduce themselves as undifferentiated cells and they migrate as undifferentiated cells. From a clinical standpoint in the condition of hypertrophy they are carrying out a normal communistic existence, i.e., producing a special tissue which is to work in conjunction with other special tissues of the multicellular organism. In the second condition they produce an indeterminate condition the end result of which cannot be prophesied by any known methods. In the third condition experience has taught us that the cells, when they are in the stroma, continue their migration even to distant organs, grow and eventually destroy the life of the organism.

Regardless of whether we call a chronic inflammatory mammary condition, chronic mastitis and benign tumors, e.g., adenomata, fibromata, adenofibromata, fibro-adenomata, fibromyxomata, myxofibromata, myxomata or intracanalicular fibro-adenomata, adenofibromata, myxomata, adenomyxomata or any other names which have been given to the various conditions or whether we call a condition Schimmelbusch's disease, Reclue's disease, abnormal involution, senile parenchymatous hypertrophy or any other of the 10 or 12 synonyms, or whether we call carcinoma scirrhus, adenocarcinoma, comedo-carcinoma or carcinoma simplex or any other name, the fact relative to the conditions which are present remains simply one of reaction on the part of the cells involved and so far as the clinical, surgical, and pathological experience of the writers has been concerned the patient's welfare depends absolutely upon a decision as to whether the cytologic activity is benign, indeterminate, or malignant. The names of tumors play no great rôle. The nomenclature as it exists in textbooks does not produce a clear conception of what actually exists from the clinical standpoint. It is true that neoplasmata are grouped in textbooks into benign and malignant and under each group there is a long list of names of conditions which have been described in detail from the pathologists' standpoint but that this detailed description with its nomenclature has been of great efficiency to the clinician may be answered in the negative from the experience in this clinic. A glance at the percentages of error which has been made during the utilization of and on account of the present textbook nomenclature is sufficient to support the statements made above.

In summarizing the writer's solution of this problem it may be stated that the main object is the proper treatment of the patient which may be best accomplished by a simple realization of the fundamental facts that the history of the breast is the history of its tissues in their battle against irritants and destructive agencies of any kind and that all tissue cells react in certain ways to these agencies depending upon the quality, quantity, and duration of action. The histologic pictures of this reaction represent tissue destruction, tissue replacement, cellular regeneration, cellular neoplasia and cellular migration.

Clinical experience has taught that destruction of tissue cells may be complete and fatal to the organism or it may be incomplete and the destroyed tissues be replaced or regenerated. It may be incomplete and still great enough to prevent complete replacement or regeneration during which a new-growth (neoplasia) occurs, the cells of which may become differentiated and are benign, or remain undifferentiated migrate and are malignant. These

are the clinical effects of reaction, and it is these simple effects which should be borne in mind by the clinician, surgeon, and pathologist regardless of the name of the tumor.

The conditions of the tissues are really what the clinician desires. From this by correlation with clinical experience he may decide upon the benignancy or malignancy, the degree of treatment, and the future of the patient.

It may be definitely stated by a pathologist familiar with the stages of tissue reaction that there exists primary, secondary, or tertiary cytoplasia which have three definite clinical meanings regardless of names of tumors which do not always have definite clinical value. If the clinician or surgeon desires still to group his conditions into encapsulated and non-encapsulated then he is dealing with

Encapsulated or Non-encapsulated	Primary, Secondary or Tertiary	Cytoplasia

His error then becomes dependent simply upon his ability to determine by signs, symptoms and clinical history whether he thinks a conditions is benign, malignant or doubtful. The tissue involved and the degree of involvement can only be decided by the surgical pathologist and this decision can be made during operations without added injury to the patient provided the lesion is excised instead of incised.

At this juncture clinicians will doubtless say that there are so many cases which are quite evident. True, as this is, there still remains a 5 per cent error in the diagnoses of carcinoma and a failure to discover 22 per cent of carcinomata. These percentages demand the immediate service of the laboratory. If the plan set forth in this series of papers be adhered to, the 5 per cent and 22 per cent will be done away with; the apparent error of 8 to 50 per cent will completely disappear and such non-descriptive and unscientific terms as mass, tumor, nodule, and growth and names of tumors with question marks will not be necessary in clinical diagnoses.

The medical code for pathologic conditions in the breast will be transformed from one of inefficiency to one of scientific efficiency and the patient will reap the benefit.

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EXTERNAL RUPTURE OF A PELVIC HÆMATOMA DURING INSTRUMENTAL DELIVERY[1]

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THIS case occurred in the outdoor obstetrical service of the New York Post Graduate Hospital, and is of especial interest in that it is apparently the first case of hæmatoma in the literature complicating the second stage of labor.

Mrs. M., age 38, XI-para. *Previous history.* One miscarriage and two stillbirths at term from mal-presentation of fœtus and operative delivery. Menstrual history of no significance. Physical examination showed heart and lungs normal. The patient was obese with a large relaxed and pendulous abdomen.

Pelvic measurements. Interspinous, 26 centimeters; intercristal, 29 centimeters; right oblique, 23 centimeters; left oblique, 23.50 centimeters; external conjugate, 22 centimeters. Promontory not felt. Outlet was roomy. Presentation was vertex. Position L. O. A. Due February 14, 1912.

Labor began at the home of the patient at 7 a.m., February 28. The first stage was normal lasting thirteen hours. The second stage began at 8:30 p.m., with the rupture of the membranes and fairly strong "bearing down" pains. The uterine contractions, however, gradually subsided in force and frequency, and with complete dilatation of the cervix, 2 cubic centimeters of pituitary extract (Armour's) was injected intramuscularly in two doses at five minutes' intervals. This had no apparent effect upon the pains.

After two hours in the second stage, with diminishing of uterine contractions and no advance of the presenting part, and as the fœtus seemed large and was overterm, it looked at the time to be a straight case of uterine inertia with indications for a forceps delivery. The head was in the brim of the pelvis in the L. O. A. position. Both maternal and fœtal hearts were in good condition. No masses were felt by vagina. With the patient on a kitchen table and placed in the lithotomy position, the vulva was prepared as usual and chloroform anæsthesia given. The solid bladed forceps was first tried and several attempts made to introduce them to secure an application to the sides of the fœtal head, but the second blade could not be rotated opposite the first or posterior blade. Traction, however, was made with the blades in the oblique application, with slipping of the blades.

A change was then made to the axis traction instrument. The same difficulty in application was encountered here, so traction was made with blades in the oblique application. Strong intermittent traction was made for one hour with very slow advance of the head. As the head appeared on the perineum and when further traction was exerted to deliver it, a gush of dark clotted blood was propelled with great force from the introitus, striking the operator on the left shoulder. After this apparent rupture of some structure, the head was easily delivered over the perineum. The birth of the shoulders and the rest of the body was readily effected. The child was moderately asphyxiated but cried on spanking. There was, however, a right sided facial paralysis. The child weighed 10 pounds, 4 ounces. On examination of the vulva to ascertain the amount of damage done, and the origin of the hæmorrhage, a vertical external laceration about 3 centimeters long was found to exist at the upper angle of the anterior and left vaginal walls and labium minus close to the pubic ramus, and from which a slight oozing of blood was seen. Thinking of a possible ruptured uterus, the gloved finger was introduced into this opening for exploration. It was found to lead into the cellular tissue outside of the vaginal walls and into a cavity extending upward alongside of the cervix and lower uterine segment and base of the left broad ligament about 12 centimeters from the vulva. On further examination the finger came in contact below with the posterior surface of the pubis and anteriorly in the median line with the neck of the bladder. The uterus and bladder were found intact. The patient was in considerable shock by this time — the pulse being 150 and the body and face pale and perspiring freely. The cavity was packed with eight yards of 1½ inch iodoform gauze with cessation of the bloody oozing. Procedures were then established to combat shock, from which the patient rallied in a short time. On the following morning the pulse was 100 and temperature 99°. It was necessary to empty the bladder per catheter for three days. The temperature did not go above 100° at any time, and the pulse gradually came down to normal. The packing was partially removed on the second and third day and completely by the fifth day. The cavity gradually filled in and was completely healed on the twelfth day postpartum. The child developed stupor and refused to nurse on the third day. Spasms of lips and left eyelid and later nystagmus developed with its death on the fifth day, apparently from a meningeal hæmorrhage.

The unusual condition of the mother was evidently due to an unrecognized pelvic hæmatoma formed during the first stage of labor in the cellular tissue at the base of the broad ligament, subperitoneally and above the pelvic fascia. The

[1] Presented at the New York Academy of Medicine, April 21, 1914.

collection of blood was not of sufficient amount (estimated at about 4.5 to 5 ounces) to cause an acute anæmia, but large enough to prevent the advance of the head with normal uterine contractions and to prevent the proper application of the blades of the forceps. As forcible traction was made, and with the advancement of the head, the hæmatoma was forced downward dissecting its way through the cellular tissue, covering the pelvic floor, and reaching the pubic ramus it was deflected laterally until arrested by the fœtal head and then toward the median line and there arrested by the anterior ligaments of the bladder. The strong fascia covering the levator ani muscle prevented its making its way posteriorly; so being forced downward by the advancing head, rupture externally occurred through the inferior triangular ligament under the decending ramus of the pubis.

In reviewing the literature on this subject, it was found that Dr. Williams of Baltimore had collected 33 cases of subperitoneal hæmatomata, including one of his own. Since that time other cases have been added to these.

As regards the etiological factor in these cases, the bleeding has been found to emanate from the capillaries at the base of the bladder instead of the larger vessels. The small vessels are separated from their attachments by the traumatism in the advancing of the presenting part and later rupture causing a gradual accumulation of blood in the cellular tissues. Williams, in his case, which came to operation, found only a capillary oozing from the inferior and superior surfaces of the bladder, which was controlled by packing. In Perret's case which was autopsied, it was proved by injecting the vessels that the larger ones were intact and that the bleeding came from the capillaries.

I might say that the majority of cases reported were hæmatomata that became apparent following delivery, and so far I have not ascertained any that complicated the second stage of labor. In this case, if the hæmorrhage in the cellular tissue had not obstructed the advance of the presenting part making it necessary for an operative delivery, it is a matter for conjecture whether the collection of blood would have increased postpartum and given rise to symptoms of internal hæmorrhage and signs of a tumor mass which according to the urgency and size of the hæmorrhage would have required operative measures for its relief.

A PRIMARY MALIGNANT NEOPLASM OF THE FALLOPIAN TUBE, PROBABLY DECIDUOMATOUS

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PRIMARY malignant neoplasms of the fallopian tubes are seen sufficiently infrequently to warrant the reporting of another case. The most commonly encountered neoplasms are the carcinomata. Of these, Vest (1), in 1914, reported 132 cases. Lipshitz (2), in the same year had collected 144 cases to date, but considered that many of these were not acceptable because of the lack of microscopical verification of the diagnosis. Tcharnaca (3), 1914, mentions many of the same cases referred to by the above authors, and in addition 10 or 12 other cases. Other isolated cases are reported by Cumston (4), Levitski (5), Karakoz (6), Cesar (7), Forsner (8), and Gurd (9). It is possible that some of these reported carcinomata have not rightfully belonged in this group. LeCount (10) selected 21 out of 52 cases that had been reported up to 1901, excluding 15 because of insufficient data and 37 as papillomatous growths known to be due to inflammation. The danger of confusion is discussed by Kraus (11) in an article on the carcinoma-like epithelial growths in the tubes, bringing out the point that papillomatous outgrowths of the mucous membrane are frequently associated with inflammatory conditions here. Voight (12) reports a case of carcinoma-like growths associated with tuberculous salpingitis.

Primary deciduomata and sarcomata are still more rarely seen. Quénu and Longuet (13) found references to only one primary deciduoma of the tube and six "sarcomata" (3 other cases however being classified as mixed tumors) in the literature to 1901. We have found no other cases reported as tubal sarcoma to date. In 1905, Risel (14) collected 11 cases of primary tubal deciduomata out of 300 reported cases of chorio-epitheliomata. Proust and Bender (15) refer to one by Lofquist (1909). Cope and Kettle (16), Bazy (17) (1913), and Huguier (18), each report another, making a total of 15 cases. Sarcomata and deciduomata of the ovaries are not included among these. Of these tumors the carcinomata have been the more completely analyzed. Etiologically, previous inflammation has been generally held as the most frequently prevocative factor. However, in the literature as reviewed by Vest, possible infection had been found in 57.7 per cent of cases and in 42.3 per cent, there was no history of infection. On the other hand, there have been only 4 cases of primary carcinoma of the tubes among the 19,000 cases of infected tubes seen in Johns Hopkins Hospital. The age at which carcinoma attacks the fallopian tubes corresponds to the usual so-called "cancer age," the majority of cases occurring between 40 and 50 years; the youngest patient on record being 27 years old, the oldest, 70.

Pathologically these tumors have been found to be characteristically papillomatous. Sanger and Barth (19) classify them as papillary and papillary-alveolar; Friedenheim (20) as papillary and papillary-alveolar mucous membrane carcinomata and alveolar wall carcinomata. Falk (21) speaks of the benign papillomata, the malignant papillomata and the papillary epitheliomata. None of these authors seems to have noted any other form in this tissue; in fact any form which did not in some place show a distinctly papillomatous arrangement. As the growth enlarges, the tube becomes filled and distended, the walls may thicken or be stretched thin and may be invaded but are rarely perforated. These tumors are regarded as highly malignant but of rather slow growth before symptoms are pronounced (Vest). Direct inplantation on the peritoneum is frequent and in location sometimes suggest the path of transmigration of the ovum.

The chief symptoms, as outlined by Vest (1), include: discharge, pain, and abdominal distention. The discharge may be leucorrhæal or, as is more characteristic, blood-tinged, copious, continuous or in periodic gushes, and usually acrid or malodorous. The pain is frequently colicky and usually localized in one of the lower abdominal quadrants, but may radiate to the upper abdomen, back, and legs. Later, it becomes constant and severe. The abdominal distention or tumor is sometimes the first symptom complained of and may extend up to the umbilicus. Menorrhagia and metrorrhagia are the menstrual disturbances noted and when these appear after the menopause, suspicion is aroused even though the uterus seems free from pathology. Curettings in such cases have been reported negative in several instances. The late symptoms include loss in weight, cachexia, ascites, and painful urination and defæcation.

Malignancy following extra-uterine gestation is characterized by symptoms as illustrated by Bazy's case: a period of amenorrhoea with an abdominal tumor growth and associated with emaciation, anæmia, and pain, the enlargement being found to be attached to one side of the uterus.

REPORT OF CASE

The patient, a Polish woman, age 20 and single, a domestic by occupation, entered Cook County Hospital, March 28, 1915, complaining of abdominal pain. The history, as obtained through an interpreter, was that following a period of amenorrhœa of two months (though always menstruating regularly before), and 2 weeks before coming to the hospital, she suddenly began to have severe pain, especially on the right side of the lower part of the abdomen. She had chilly sensations and vomited several times with the onset of this pain. The pain had been more or less continuous throughout the two weeks but seemed to be decreasing in severity. There were no urinary difficulties nor was there any vaginal discharge. Upon examination, the patient appeared rather pale, fairly well nourished, complaining very little, but seemed acutely ill. There was a mass occupying most of the lower right quadrant of the abdomen. It was moderately tender but associated with little muscular rigidity. Upon vaginal examination, the uterus was found to be displaced anteri-

orly and to the left, the cervix being flattened against the symphysis. The temperature ranged from 98.6° to 104° and the pulse from 120 to 140 during the first 36 hours of her stay in the hospital. The leucocyte count was 22,000. The diagnosis of infected extrauterine pregnancy was considered the most probable.

An operation was performed by Dr. R. T. Vaughan, and disclosed a large friable bloody mass to the right and back of the uterus. The condition was interpreted as an ectopic pregnancy in the right tube which had ruptured, some two weeks before, into the broad ligament, dissecting apart the layers of peritoneum. Masses of soft material, here, and under the peritoneum back of the uterus, were regarded as old blood-clots undergoing absorption and septic degeneration. There were about eight ounces of free blood in the peritoneal cavity, some appearing to ooze from the open fimbriated end of the right tube. The left tube was œdematous and many dense adhesions were present involving the tubes and posterior wall of the uterus and the intestines and appendix. The base of this mass was so wide that clamping and excising were not attempted, but the contents of the mass were shelled out and bleeding stumps containing the ovarian artery and anastomosing branches from the uterine were ligated, and a five yard gauze drain packed into the cavity, the free end extending through the abdominal incision. For the next few days the patient was very ill, and at the end of a week of continued temperature of 102° to 104°, pulse 108 to 132, and leucocytosis of 20,000, a fluctuating mass was found in the posterior cul-de-sac and diagnosed as a pelvic abscess. A posterior colpotomy was performed and about one quart of foul, bloody, purulent fluid removed and a drain inserted. The patient continued a septic course, feet became swollen, urine showed albumin and casts, and about a week before she died, fresh blood was discharged through the posterior colpotomy wound, together with masses of tissue grossly resembling placental tissue. Considerable necrotic tissue with a very offensive odor was also passed. These hæmorrhages and offensive discharges continued until the patient's death, May first.

An autopsy was performed May 5, 1915. The following is a record of the gross findings:

The body was that of a small, poorly nourished female; no icterus; superficial lymph-glands not palpable. There was a laparotomy wound about 9 centimeters long, gaping about 4 centimeters to the right of the midline below the umbilicus, with a floor made of the fascia of the muscles. The lower extremities were œdematous, especially the right. There was increased pigmentation of the areolæ and hypertrophy of the mammary gland tissues, but no milk.

In the abdominal cavity the peritoneum was everywhere blackened and tags of fibrous and fibrinous adhesions were scattered through the cavity. Fat was very scant. In the dense adhesions present under the laparotomy wound was a pocket made up of necrotic pink masses with softened centers; above the umbilicus were two pink vascular masses 2 to 3 centimeters in diameter, adherent to the intestine, and in the adhesions between the intestines a few other similar but smaller masses. The entire pelvis was filled with a purulent mass of necrotic tissue and pus, and some fæcal material. Above, this was bounded by the sigmoid and adhesions, there being a small communication between the sigmoid lumen and the cavity; below there was an opening about 2 centimeters wide into the vagina, behind the cervix. The wall of the cavity was formed by necrotic purulent tissue, apparently derived from the pelvic connective tissue. The uterus formed part of the inferior surface.

The pleural and pericardial cavities were normal. The lungs collapsed well. A little fluid was present posteriorly, in the lower part of the left lung slightly more than in the right. Very little anthracosis, bronchi were filled with a muco-pus, trachea normal, peribronchial lymph-glands were not unduly enlarged. There were no areas of consolidation in the lungs and no tumor nodules.

The heart weighed 210 grams, pericardium, myocardium, endocardium, and valves were normal. Slight sclerosis was present at the beginning of the aorta. There was a recent laminated thrombus in the left common iliac vein, but slightly adherent, and terminating at the bifurcation.

The liver weighed 100 grams; cut surface, light yellow, but the lobular markings not unduly conspicuous; gall-bladder normal.

The spleen weighed 60 grams, tissue normal.

There was a perforation of the sigmoid into the pelvic abscess, but no other changes in the gastro-intestinal tract.

The adrenals were small and poor in cortical substance.

The kidneys weighed together 300 grams; the left renal vein and its tributaries were occluded by a friable, laminated thrombus; the smaller veins of the right kidney were thrombosed. The substance of the kidneys was very pale, the cortices light in color; the capsule stripped easily leaving a smooth surface. The bladder was adherent to the uterus, the lining of the bladder normal.

Generative organs: The ovaries could not be found because of adhesions and necrosis. The left fallopian tube was hyperæmic, œdematous, and had a 1 centimeter nodule of soft tissue. The uterus was close to the symphysis and the fundus was adherent to it; the cervix was increased in diameter. There was apparently no decidua in the cavity of the uterus, which seemed normal. The lymph-glands in general, were normal.

The muscular system was not well developed, but presented no abnormalities. The skeleton was normal, the bones of the pelvis were not eroded by the abscess.

The gross anatomical diagnosis was as follows:

Primary malignant neoplasm of the fallopian tube, infiltrating pelvic tissues; pelvic abscess communicating with sigmoid flexure and vagina; diffuse recent

fibrous and fibrinous peritonitis; encapsulation of the pelvic abscess by fibrous adhesions; incompletely united laparotomy wound; encapsulated neoplastic masses in the peritoneum; thrombosis of the veins of both kidneys; recent thrombosis of the left common iliac vein; œdema of the lower extremities; parenchymatous nephritis; hypostatic œdema of the lungs; slight fatty changes in the liver; extreme emaciation.

Upon microscopical examination, these masses of tumor tissue are found to be of peculiar structure, the characteristic feature being the variety of cells present and the absence of definite arrangement. There is no papillary or alveolar arrangement to be found. The cells range in size from 15 to 30 microns, are epithelioid in type, have large round and oval nuclei 10 to 20 microns in diameter, showing many mitotic figures. Some of the larger nuclei seem grouped together without demonstrable cell boundaries separating them. The larger cells especially are highly phagocytic, containing red blood-corpuscles, leucocytes, and blue staining bodies. There are also a few pink staining hyaline bodies, oval in shape, between and nearly as large as the cells. The blood content of the tissues is variable. Some parts have only a few red cells scattered between the tumor cells and in other places there are large spaces containing blood with and without endothelial linings separating them from the tumor cells. Connective tissue, as brought out by the Van Gieson and Mallory stains, is present in comparatively small amount, and this for the most part as a capsule. In a section of the fallopian tube from the left side there is invasion from without by a cell mass resembling histologically the other tumor masses. This also is well encapsulated. There is present here also, œdema of the stroma, occlusion of the lumen, erosion of the mucosa and round cell infiltration of the mucosa. Regional lymph-glands and others are free from metastases. The wall of the uterus is œdematous, with slight necrosis of the outer portion of the wall but no tumor growths and no decidua formation. The wall of the pelvic abscess contains comparatively few leucocytes but many tumor cells.

To recapitulate, we have here a patient, 20 years old, presenting history, symptoms, and physical findings suggesting an ectopic pregnancy and considered as such without question at the time of operation. Four weeks after the operation the patient died of hæmorrhage and sepsis, with a pelvic abscess perforating the sigmoid and opening into the vagina, and thrombosis of the iliac and renal veins. Upon postmortem examination the wall of the pelvic abscess was found to be made up of extremely soft neoplastic tissue of peculiar polymorphous cells, and encapsulated nodules of similar histological structure were found implanted on the peritoneal surfaces, both parietal and intestinal, and invading the left fallopian tube. There were no metastases in the lymph-glands nor in remote organs, as in the lungs. Grossly the isolated tumor nodules did not suggest syncytioma, being encapsulated and pale, and not of the soft, ragged, intensely hæmorrhagic nature, variegated in color, generally characterizing this form of neoplasm. The pelvic growth was so much altered by infection that its characteristics had little significance. The rapidly destructive growth is evidenced by the erosions into the sigmoid and into blood-vessels causing hæmorrhages which almost exsanguinated the patient (possibly accounting for the pale appearance of the peritoneal nodules).

In studying other reports of malignant tumors of the tubes, our attention is attracted to the fact that the carcinomata have all occurred in women of the so-called cancer age, the youngest reported having been 27 years old. Also, these have been characterized histologically by papillary or papillo-alveolar growth. (Sanger and Barth, 19; Friedenheim, 20; and Falk, 21). Deciduomata, on the other hand, have been noted in younger individuals, even as young as 17 years (Huguier). Histologically, where found, deciduomata may be grouped into the typical, atypical and intermediate forms; typical, showing Langhans' cells (Schmauch, 9) as well as syncytial cells and masses; atypical, syncytial cells but no masses or Langhans' cells; and intermediate, having the epithelial cells and masses only. Of these, the atypical is usually least malignant and has been regarded as a later stage of development of the other forms. These never become generalized, whereas the majority of the typical malignant chorio-epitheliomata are generalized, and many of the intermediate form have metastases in the lungs. They are all friable, bloody, and show a great tendency to invade tissues in contact, especially eroding and growing into blood-vessels. Stroma and blood-vessels within the tumors are usually inconspicuous or lacking, and everywhere the tissue is torn and disarranged by hæmorrhage (Schmauch).

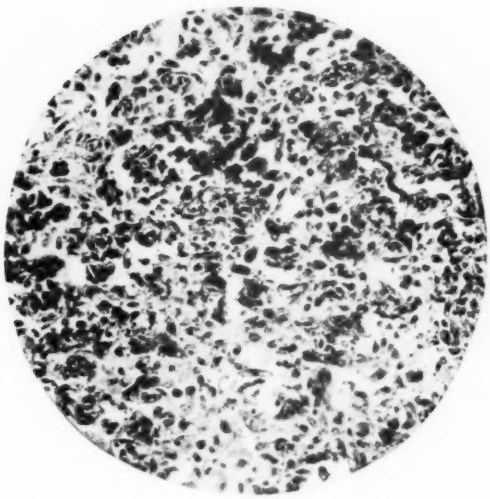

Fig. 1. Showing general structure of the growth. X-110.

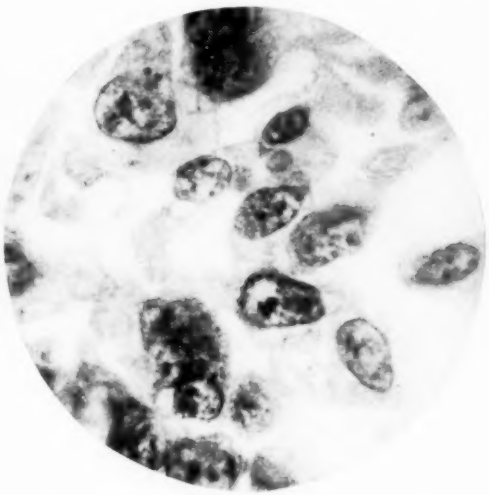

Fig. 2. High power magnification showing structure of prevailing cell types. X-1000.

From the above accounts this tumor does not seem to possess the characteristics of carcinomatous neoplasms, especially those of the fallopian tubes, but rather resembles the atypical chorio-epitheliomata, the large epithelial cells being syncytial cells, in some places uniting to form small syncytial masses. No typical Langhans' cells were found. On the basis of the clinical history, operative and autopsy findings and histological structure, we consider that in all probability the neoplasm arose in the decidua of an ectopic gestation, although the histological findings alone are not sufficiently conclusive to prove positively that the tumor is a deciduoma.

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GIANT-CELL EPULIS OF UPPER JAW[1]

By FRANCIS REDER, M.D., St. Louis

An epulis is a tumor of the gum, with a suspicion. It is the most frequent of oral tumors. Its subdivision into fibroma and giant-cell sarcoma characterizes it as a borderline lesion. Both the fibroma and the giant-cell sarcoma spring from the dental periosteum of the alveolar process, or the connective tissue between the bone of the alveolar border and the mucous membrane of the gum surrounding the teeth (Bloodgood), either outside or inside the alveolus.

An epulis may also find its origin in the interior of a diseased tooth socket. Almost any part of the alveolar ridge may prove a suitable nidus for the development of this growth, a preference, however, being shown for the canine region over the bicuspid, the bicuspid over the first molar, and the first molar over the incisor (Scudder).

The variety of epulis known as a fibroma consists entirely of fibrous tissue. It is not a very vascular tumor, and is usually of small size, projecting between two teeth. It is well circumscribed.

Its growth is slow, and the mucous membrane covering the tumor is usually normal in appearance. A fibroma does not metastasize, nor does it appear to possess the definite characteristics of malignancy, except for the suspicious action of recurring locally if not completely excised. If such a tumor is allowed to grow, ulceration and necrosis from pressure of the teeth will eventually occur.

The giant-cell sarcomatous epulis presents a somewhat different clinical picture. However, it has some characteristics in common with the fibroma; namely, it rarely metastasizes, and usually remains a local lesion confined to the alveolar process until it is treated surgically. Any surgical measure that will fail in a successful excision will cause the tumor to recur, often with surprising promptness. Under such conditions it is prone to form metastases. Although the tendency to glandular enlargement and to form distant growths is rather remote, a fact which robs it of the true character of a malignant neoplasm, its rapid and destructive growth compels it to be classified with the malignant types of sarcoma.

A malignant epulis, having a broad but more often a narrow attachment, usually appears at the edge of the teeth as a red, soft and irregularly rounded mass. The deep pigmentation which characterizes this mass is caused by its great vascularity. Therefore, it is not surprising that these tumors bleed easily upon slight trauma.

The appearance of the mucous membrane in the immediate vicinity of a giant-cell epulis gives little or no evidence of any infiltration. However, if the growth should have its seat in the alveolar ridge of the upper jaw, the likelihood of an infiltration involving the soft structures of the hard palate is not improbable. Very rarely is there an invasion of the bone by such a growth.

The consistency of a giant-cell epulis is not uniform. Although it imparts a spongy feeling throughout, certain parts of the tumor appear hard while others seem soft. In palpating such a tumor, the sensation of touching a mass of granulation tissue is forcibly brought to mind.

A malignant epulis does not cause pain, except during the formation period, when it is not easily recognized and is often mistaken for a "gum boil." At that period a toothache or a neuralgic pain, for which the patient may or may not seek relief from a physician, is the only discomfort experienced. The contact of the tumor with the neighboring structures (except the teeth, which are often pushed out of their sockets), does not in any way affect them.

Through its size an unsightly protrusion of the lip may be occasioned. The sulcus between lip and jaw as well as the one between cheek and jaw retains its normal anatomic characteristics. The well-being of

[1] Read before the Southern Surgical and Gynecological Association, White Sulphur Springs, West Virginia, December, 1916

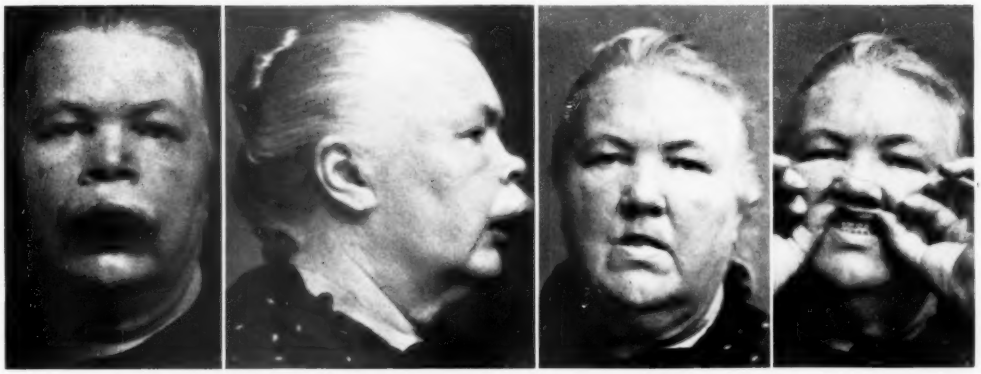

Fig. 1. Fig. 2. Fig. 3. Fig. 4.

Fig. 1. Giant-cell epulis of upper jaw.
Fig. 2. Same case, lateral view.
Fig. 3. Restoration of mouth after operation.

Fig. 4. This photograph shows the security with which the patient could wear a palate plate with teeth, after operation.

an individual suffering with an epulis is not unfavorably influenced, unless the size and location of the tumor interferes seriously with the partaking of food. Such tumors rarely ulcerate. Should ulceration occur, it is more likely to be caused by pressure than by infiltration.

On account of the great vascularity of a malignant epulis, obstinate bleeding often takes place. However, bleeding never assumes the character of a hæmorrhage. An epulis shows no predilection either for the upper or lower jaw, both jaws being equally liable to the disease. Women seem to be more prone to the disease than men, the ratio being about two to one. Age appears to have some influence, the lesion appearing usually during childhood and young adult life.

The prognosis of an epulis when the proper surgical measure has been carried out, is good. The fibrous epulis when thoroughly removed never returns. The giant-cell variety, however, shows a marked tendency to recur, and only then can the greatest promise of a cure be obtained when the growth, together with the alveolar border, has been removed.

Unfortunately, the term "sarcoma," so often used in emphasizing the nature of a giant-cell epulis, has been responsible for much heroic operative work on the jaw, some of it perhaps necessary and some of it perhaps needless. In all lesions of a suspicious nature, however, it is a great satisfaction to know that the work of eradication has been carried well into the normal tissue. In quoting some statistics, 18 cases at the Heidelberg clinic, according to Wassermann, resulted in 15 cures and 3 recurrences. Gunzert reports 38 cases — 35 well and 3 recurrences, one death from metastatic sarcoma of the brain following extirpation of fibrosarcomatous epulis of the jaw. According to Bloodgood, of 40 operations for epulis at Johns Hopkins Hospital clinic, all have remained well, including the recurrent cases (Scudder).

The case of giant-cell epulis of the upper jaw that I wish to present is that of a woman 52 years of age. She is the wife of a farmer, has never had any serious illness, and is quite stout.

One morning in March, 1913, while opening the chicken house, a hen flew into her face, striking her in the mouth, and causing several teeth in the upper jaw to be loosened. About a month later she had a bad toothache. The ache continued. She consulted a dentist, who extracted the tooth. This gave prompt relief. About two weeks after the tooth was extracted, she noticed a swelling about her upper gum "near the right eye tooth." A physician diagnosed it as a "gum boil" and lanced it. The "gum boil" did not disappear, but slowly continued to grow. Inasmuch as it was not painful, she tried to forget it.

About six months later, however, the growth had assumed such proportions that she went to a physician who treated it. The tumor then was occupying the greater part of the gum of the upper jaw. Most of the teeth had become so loosened that they either dropped out or were easily extracted. The mass was cut away twice by the physician within a month. After that it was freely cauterized with nitrate of silver. Within two weeks the growth had returned and was growing rapidly.

When I saw the patient in December, 1913, she was very much depressed over her condition. Her anxiety had robbed her of much sleep. She was only able to take food in liquid form. Her general health began to suffer.

Examination of the mouth revealed a venous-colored, spongy mass about the size of a small tangerine attached to the alveolar border of the upper jaw. It presented projections and irregularities on the surface, and extended onto the hard palate, protruding under the upper lip which it pushed upward and outward.

The mucous membrane of the alveolus was thickened, somewhat soft, and quite red. The teeth of the upper jaw were all missing, having been lost during the growth of the tumor. The sulcus between lip and alveolar border was normal. No fetid discharge was present and the mass looked clean. The lower jaw possessed most of its teeth, all in a poor state of preservation.

In removing the tumor the incision was made through the mucous membrane, quite free of the tumor. With a chisel the whole of the alveolar border of the upper jaw was removed. Bleeding was very free. It was, however, readily controlled by pressure. The patient suffered no untoward effect from the operation, and made a quick recovery, nothing unusual happening during the healing process. Four months later she was able to be fitted with a palate plate with teeth, which she is wearing with comfort.

It is now three years since the tumor has been removed. There is at present no evidence of any recurrence.

UNILOCULAR CYST OF THE PROSTATE CAUSING OBSTRUCTIVE SYMPTOMS[1]

By MOSES BEHREND, M.D., Philadelphia

A UNILOCULAR cyst in the position of the embryonic ventral lobe may have as its causation a congenital basis. According to Lowsley the various parts of the prostate gland as seen in the fœtus after the third month are the following:

1. The middle lobe or that part of the gland which is situated between the bladder and the ejaculatory ducts under the floor of the urethra.

2. The lateral lobes or those parts of the gland which arise from the prostatic furrows and the lateral walls of the urethra and extend laterally and posteriorly from that structure.

3. The posterior lobe or that part of the prostate gland which lies dorsal to the ejaculatory ducts above their entrance into the urethra and dorsal to the urethra below this point.

4. The ventral lobe or that part arising from the anterior or ventral lobe of the prostatic urethra. The tubules in the anterior lobe appear first as solid epithelial outgrowths and begin to develop about the same time as the tubules in the other parts referred to above. They are large and have numerous branches at first but in the sixteenth week they are slightly smaller than the tubules of the other lobes. At the twenty-second week these tubules have decreased in size and number and very few branches are noted. After the sixteenth week the anterior lobe is insignificant, but the tubules persist after birth at which time there are found two very small tubules. Evidence of the fact that these tubules may persist in the anterior lobe has been found in 93 specimens.

Kunitzky quoted by Lowsley found a persistent ventral lobe in one out of fifteen prostates.

It is not impossible, therefore, that a cyst may be formed in one or both of the remaining tubules of the ventral lobe. In adults, cysts of the prostate large enough to cause symptoms are rare. According to Springer, out of 600 dissections he found two cases of cyst of the prostate. There are probably few mentioned in the literature because these cysts may be so small as not to cause interference,and are thus overlooked.

In 1896 one case was found at autopsy in a man 23 years old. At that time there was no other case reported in the literature except those reported by English found in the newborn. Postmortem examinations by Springer during ten months together with the labora-

[1]Read before the Pathological Society, March 8, 1917.

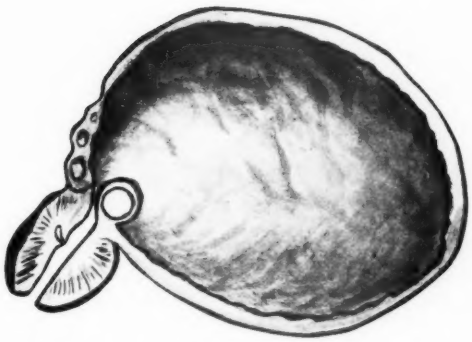

Fig. 1. Sagittal view after Abbe. Note ball-valve character of obstruction.

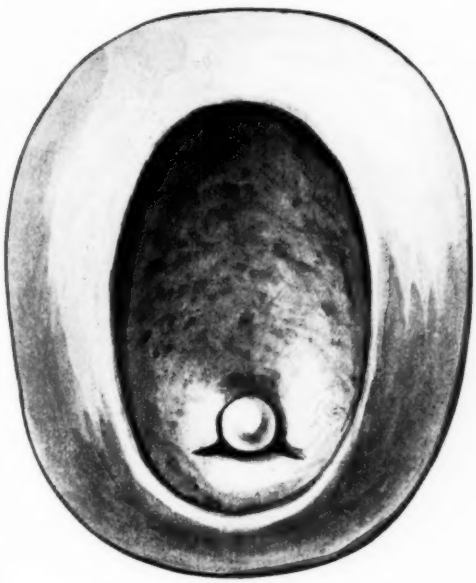

Fig. 2. Anteroposterior view after Abbe.

tory cases of former years showed four cases, three in adults and one in a boy nearly two years old.

It remained, however, for Abbe to report the first clinical case recorded in the literature in 1900. The symptoms of his patient corresponds exactly to the writer's case. The history of my patient is as follows:

M. R., age 42. Father and mother living and well. One brother died of phthisis pulmonalis. Five brothers living and well. No venereal history. Wasserman negative. Two years ago had a similar attack which lasted four days. Symptoms disappeared rapidly after the passage of sounds. On December 8, the patient consulted me and complained of symptoms of sudden onset which consisted of a frequent intense desire to urinate day and night. It was an unproductive urination. After he was apparently finished there would be a desire to urinate within ten minutes afterward. He had to strain at urination causing often the expulsion of gas and fæces. His face would become suffused and the temporal arteries would become distended when the desire came to urinate. Finally after a few days there was absolute retention of urine. This necessitated catheterization twice a day for ten days. After this function was partially restored but the bladder never seemed empty and the straining efforts at urination continued. On several occasions we tried to retain a catheter in the bladder but the burning pain referred to the left side was so intense that it rendered this procedure impossible.

Cystoscopic examinations by Drs. B. A. Thomas and F. Block revealed an enlarged left lobe of the prostate. Otherwise the bladder appeared normal. On rectal examination the left lobe seemed larger and softer than the right.

On December 31, a suprapubic cystotomy was performed. Palpation of the prostate through the incised bladder revealed at once a swelling at the ventral surface of the prostate overhanging the urethra. It felt hard, solid, and fibrous. It acted like a ball-valve. The usual incision was made over it simply to enucleate and leave the prostate alone. However, a cyst was entered the size of an ox-heart cherry; its contents contained a cloudy fluid. The cyst was then thoroughly curetted with a sharp bone curette and the bladder was closed with an invaginating suture. A drainage tube was placed at the superior pole of the bladder. The tube remained a week and ten days afterward the patient passed urine in perfect comfort for the first time in several weeks.

The oddity of this case lies in the fact that the symptoms came on suddenly. One would expect that with the gradual filling up of the cyst the symptoms would come on gradually.

The similarity of symptoms between Abbe's and the writer's case prompts me to give in full the history of his patient.

A male, aged 35, gave a history of an attack of acute retention of urine one year before, which was relieved by subsequent catheterization. One pint of residual urine was obtained. No cause of the obstruction could be definitely ascertained, a stone and hypertrophied prostate having been excluded.

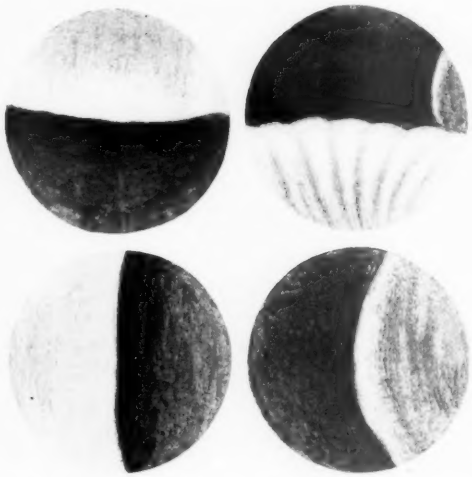

Fig. 3. Cystoscopic view. Upper left, anterior view; upper right, posterior view; lower left, right; lower right, left view.

A plausible explanation was that of a persistent atony of the bladder following overdistention. The symptoms were not relieved by repeated catheterizations. A suprapubic cystotomy was performed and a tumor the size of a cherry was discovered at the upper wall of the internal meatus and the upper portion of prostate which acted like a ball-valve obstructing the flow of urine. The cyst was transfixed by a hook. The contents became smaller when the fluid drained off. The base of the cyst was sutured, the cyst having been cut away. The bladder was drained, but drainage was removed in a few days. The patient remained free of symptoms.

Cases of hydatid cyst of the prostate with obstructive symptoms have been reported by Bangs, Jason Wood, Winterberg and others, but the cases of Abbe and the writer seem to be the only ones of unilocular cyst of the prostate reported thus far.

Finally I would say that obstructive symptoms in a young male without organic nerve lesion should not be treated too conservatively. A great deal of suffering can be avoided by an early exploratory cystotomy. My patient is now enjoying good health; urination is free and without any discomfort.

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DEPARTMENT OF TECHNIQUE

GREATER EXPOSURE IN THE KIDNEY APPROACH

By H. J. PRENTISS, M.D., Iowa City, Iowa

A TROUBLE in kidney approach is, that sometimes the twelfth rib is placed very inferiorly, or the kidney is located so high, that it is very difficult to expose the viscus. If it is possible to rotate the twelfth rib upward, considerable room is obtained. The twelfth rib is very firmly fixed, notwithstanding it is called a floating rib. The reason of this is very evident. The diaphragm is attached to it, and in contracting, to increase the vertical diameter of the thorax, the diaphragm naturally tends to swing the twelfth rib upward, provided this rib is not anchored. This naturally is opposed to the physiological purpose, which is, to obtain the greatest space for proper lung expansion. How then, has nature handled this problem? The middle layer of the lumbar fascia, i.e., the fascia between the sacrospinalis (erector-spinæ) and quadratus-lumborum extends to the twelfth rib, since the uppermost insertion of this muscle is in this rib; and this middle layer of fascia is a part of the fascial covering of this muscle. Therefore, this fascia becomes very much thickened between the transverse process of the first lumbar vertebra and the twelfth rib (lumbocostal ligament). This naturally resists upward displacement of the twelfth rib as the diaphragm contracts, and is in fact a very strong ligament. If therefore we cut this ligament, the rib is freed and can be displaced so as to override the eleventh rib, increasing the opening approximately an inch and one-half.

The anatomy of this approach, I have endeavored to illustrate. In Fig. 1, on the right, is seen the latissimus dorsi arising by its aponeurosis of origin from the spinous processes, etc. This aponeurosis blends with the posterior layer of the sacrospinalis fascia. On the left

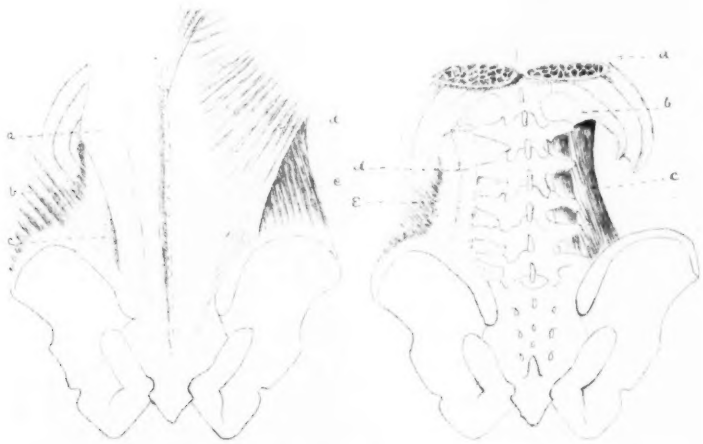

Fig. 1 (at left). *a*, Sacrospinalis enclosed in lumbar fascia; *b*, internal oblique; *c*, quadratus lumborum in fascia; *d*, latissimus dorsi; *e*, external oblique.

Fig. 2. Sacrospinalis removed. On left, quadratus lumborum in fascial covering. On right, fascia removed except lumbocostal ligament. *a*, Sacrospinalis; *b*, lumbocostal ligament; *c*, quadratus lumborum uncovered; *d*, lumbar fascia enclosing quadratus lumborum; *e*, internal oblique.

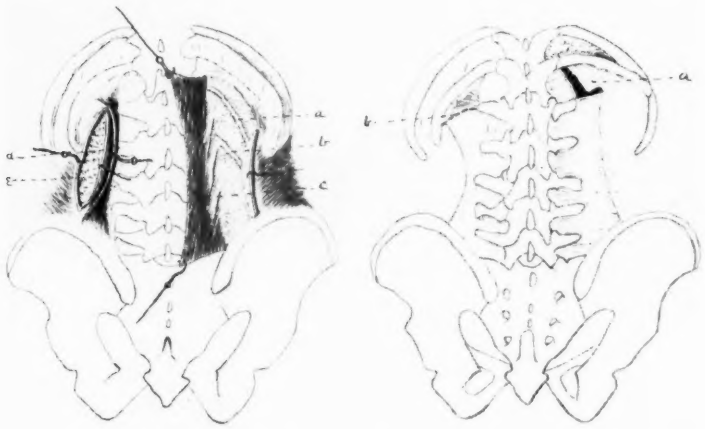

Fig. 3 (at left). On right, quadratus lumborum detached and reflected, exposing twelfth and iliohypogastric and inguinal. On left, quadratus lumborum pulled medially, anterior fascia incised exposing extraperitoneal fat. *a*, Twelfth thoracic nerve; *b*, iliohypogastric and inguinal; *c*, quadratus lumborum; *d*, fascia incised exposing subperitoneal fat.

Fig. 4. *a*, Lumbocostal ligament incised and twelfth rib rotated, *b*, dotted line indicating the external arched ligament of the diaphragm, but separated from the lumbocostal ligament by the quadratus lumborum.

in Fig. 1, the latissimus dorsi has been removed, exposing the sacrospinalis in its fascia, and the lower limit of the quadratus-lumborum, in its fascia, extending laterally to the sacrospinalis to attach to the crest of the ilium. This fact of the quadratus-lumborum extending laterally to the sacrospinalis near the iliac crest, is of importance, as an incision in this region brings us directly upon this muscle fascia, which is thus readily opened. In Fig. 2, on the left, the sacrospinalis has been removed, exposing the fascial compartment containing the quadratus lumborum, and from which fascia arises the common aponeurosis of origin of the internal oblique and transversalis. On the right the fascia of the quadratus lumborum has been removed, except at the level of the transverse process of the first lumbar vertebra, where its thickening (the lumbocostal ligament) extends between this process and the twelfth rib. This ligament is so dense, that one has no difficulty in feeling it. Figure 3, shows on the right, the quadratus lumborum reflected medially, exposing the anterior layer of the lumbar fascia, which is a part of the sheath of the quadratus lumborum. Here we see the twelfth thoracic nerve and the common trunk of the iliohypogastric and ilio-inguinal coursing through this fascia, because of its thinness. The common aponeurosis of origin of the internal oblique and tranversalis, which arises from the lumbar fascia surrounding the quadratus lumborum is so dense, that these nerves are not seen as they pass through it to get between these two muscles.

This point is worth considering, because it is necessary to open into the fascial compartment of the quadratus lumborum to liberate the lumbocostal ligament, and one can avoid these nerves in entering the abdominal cavity. On the left, the quadratus lumborum is reflected medially, exposing the anterior layer of the lumbar fascia, which is incised, exposing the fascia propria or extraperitoneal fat. Figure 4, on the right, shows this lumbocostal ligament cut through, liberating the twelfth rib which is rotated upward, being limited in its range of rotation by the eleventh rib. On the left is shown a dotted line, indicating the position of the external arched ligament of the diaphragm. Since we are behind the quadratus lumborum in this approach there is no danger of injuring the abdominal content or the nerves or the anchorage of the diaphragm. Figure 5, is a ventral view of the postabdominal wall. Here the left half of the diaphragm has been removed, the right half remaining. It shows the anchorage of the diaphragm, viz, the crura, internal, and external arched ligaments. On the left is dotted

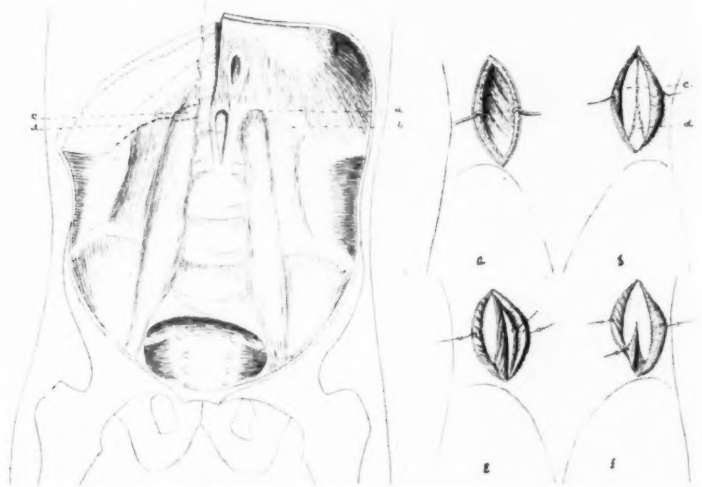

Fig. 5 (at left). Diaphragm removed on left. To compare origin of diaphragm with lumbocostal ligament. *a*, Internal arched ligament; *b*, external arched ligament; *c*, transverse process of first lumbar vertebra behind psoas; *d*, lumbocostal ligament behind quadratus lumborum.

Fig. 6. *a*, Skin and fascia incised exposing latissimus dorsi; *b*, latissimus dorsi incised; *c*, sacrospinalis; *d*, quadratus lumborum enclosed in lumbar fascia; *f*, middle layer of lumbar fascia incised exposing quadratus lumborum; *e*, incision carried to upper limit.

the transverse process of the first lumbar vertebra, which is behind the psoas, and also the lumbocostal ligament, which is behind the quadratus lumborum. This figure indicates the perfect freedom from injury in approaching from behind. Figure 6, on the left, shows the incision through the skin and superficial fascia, which is very thick in this region, owing to its filling in the hollow of the back, due to the latissimus dorsi being adherent to the sacrospinalis fascia. The latissimus dorsi is exposed. On the right, the latissimus dorsi has been incised and reflected. We come upon the lumbar fascia. Here we see the fascia of the quadratus lumborum extending laterally, above the crest of the ilium, to that of the sacrospinalis muscle.

In Figure 6, on the right (*f*), the fascia over the quadratus has been incised and reflected medially exposing the quadratus lumborum muscle. We now may enter the compartment of this muscle and carry the incision freely upward to the rib on the left (*e*). The lumbocostal ligament is readily felt, incised, and our purpose accomplished.

MODIFICATION OF THE UNIVERSAL INCISION IN EXPLORATORY LAPAROTOMY

By Dr. DELFOR DEL VALLE, Buenos Aires, Argentine

THE progress which has been made during the last few years in connection with abdominal surgery is due to the roentgen ray and to exploratory laparotomy which have permitted us to prove the existence of pathological conditions in the digestive tract, such as kinks, adhesions, Thompson's membranes, ptosis, and any modifications of the omentum.

The present day perfection in surgery (technique and instruments) has transformed laparotomy into an exceedingly simple and innocuous operation, and at the same time permits of the total exploration of the abdomen. The coexistence of divers diseases, such as ulcers of the stomach or duodenum, appendicitis or cholecystitis, makes it necessary in a great many cases to explore the various organs besides treating the principal complaint.

The Anglo-American school, with an eminently practical spirit, has adopted an incision which by its situation and dimension is equally useful for any of these co-existent processes. I am referring to the incision generally known as the "universal laparotomy" incision, which extends from the costal margin down to the umbilicus or lower, if necessary, parallel and one inch from the median line, opening the sheath of the rectus muscle, retracting the muscle aside and penetrating into the abdomen through an incision of the posterior wall of the sheath. In Professor Decoud's clinics this method has been used for the last two years, with really good results. Although at first the incision might impress one as being rather exaggerated in length and its closure troublesome, with experience a surgeon realizes the enormous advantage to be derived from its use, and inevitably adopts it.

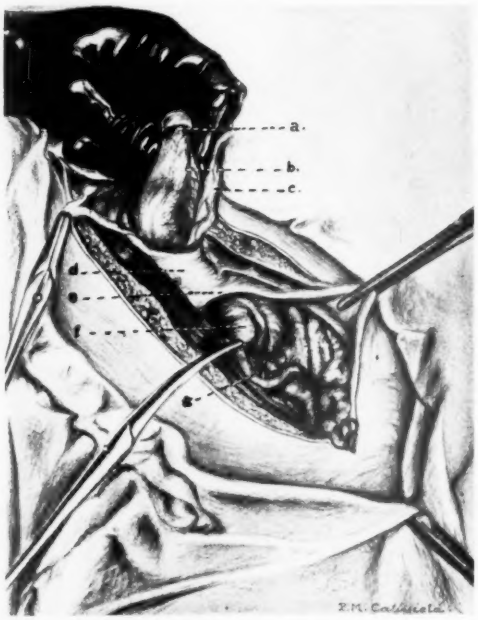

Fig. 1. Author's incision. *a*, Pylorus, *b*, duodenum, *c*, stomach, *d*, aponeurotic bridge, *e*, Douglas' arch, *f*, cæcum, and *g*, appendix.

Nevertheless it has several disadvantages, especially in those cases requiring total exploration of the abdomen, or where the existence of adhesions makes necessary a considerable extension of the incision, even down to the level of the pubis. We have noticed three principal disadvantages: (1) The suture of the posterior portion of the rectus sheath becomes more and more difficult as the incision is lengthened, owing to the lateral traction of the abdominal muscles. (4) There is always the danger of an evisceration through the cicatrix. (2) A great incision exposes the operator during the operative procedure to the emptying of the abdomen, especially in those cases of bad anæsthesia, making it necessary to have an assistant. (3) Besides all this, there is added the fact that the many manipulations required in the above procedure increase the shock, and this we should always try to avoid.

Convinced of the necessity of a systematic exploration in all abdominal operations and more so in chronic gastro-intestinal cases (chronic abdomen of the Americans), and taking into consideration all the disadvantages mentioned in the cases in which it is necessary to lengthen the incision, I have adopted a system which though slightly modifying the "universal incision" has all its advantages.

TECHNIQUE

The technique which is employed is as follows: One inch parallel to the median line, an incision is made on the right-hand side of the abdomen,

commencing two or three finger breadths below the costal margin and extending the same distance above the pubis. On the same line the sheath of the rectus is opened, and the muscle retracted outward. In this way it is possible to make an incision on the posterior portion of the rectus sheath, keeping the same distance from the median line. It is at this step that the modification of the incision occurs. The posterior wall of the rectus sheath is opened with two subincisions which leave between them an aponeurotic bridge of an inch or more in width. The inferior incision commences at Douglas' arch and one or two inches above this arch, the superior incision terminates.

In this manner it is possible to explore all the abdomen and pelvis, examine all the viscera, and drain the pelvis, avoiding the inconveniences mentioned above.

In the plate which accompanies this article we find in the middle of the incision the aponeurotic bridge (*d*) mentioned, which is strengthened on its lower portion by Douglas' arch (*e*). In the upper opening we notice that the hand is exploring the pylorus and the duodenum (*a*, *b*, and *c*). Through the lower opening we notice the cæcum and the appendix held by a clamp (*f*, *g*).

My experience convinces me that this technique is very satisfactory in extensive explorations of the abdomen for chronic or acute lesions.

TREATMENT OF A DOUBLE FEMORAL ANEURISM BY PROXIMAL OCCLUSION WITH AN AUTOPLASTIC FASCIAL FLAP[1]

By EDWARD G. JONES, A.B., M.D., F.A.C.S., and CHARLES E. WAITS, M.D., Atlanta, Georgia

ANEURISMS of the upper femoral offer peculiar problems for at least three reasons: (1) the many branches constitute a formidable handicap in any type of reconstructive operation; (2) obliteration of the vessel entails a material danger of gangrene; (3) when complete obliteration by ligature or otherwise is practiced and gangrene is escaped some degree of functional disturbance in the leg is probable. The gloomy truth of the last named fact is impressed on one by the exhaustive article of Dr. Halsted[2] on ligation of the common iliac, which appeared in 1913.

This report, however, is not concerned with the wisdom or unwisdom of proximal ligation for femoral aneurisms; but rather with the question how proximal ligation, when necessary or wise, may be done.

We take it to be an accepted fact that the ideal closure above an aneurism is that which *nearly*, but not entirely, occludes the lumen of the vessel.

If now one can almost occlude the vessel by some method which does not carry with it the danger of erosion and hæmorrhage, such as the metal band entails, he will at least have added to the safety of the procedure. Dr. Halsted has met the objection to the metal hand by offering instead strips of fascia lata (autoplastic or heteroplastic) and sections of aorta (heteroplastic) and has been pleased with the results[3] He is impressed with the belief that if the band does not permanently partly occlude the vessel, the occlusion will last long enough to cure the aneurism. Dr. Matas, at the late meeting of the Southern Medical Association in Atlanta, stated that he has been experimenting recently with bands of rubber tissue for partial occlusion of certain vessels. The results of this addition to his already well-known work of this sort will be awaited with interest. Where the occlusion may be accomplished by autoplastic tissue this would seem preferable to any other material. If, furthermore, the site of the proposed occlusion is such as to allow an adequate constricting band to remain attached at one end the possibility that the band will become permanently grafted upon the vessel, or at least last longer than a similar detached piece of tissue, will certainly be increased and the probability of cure of the aneurism correspondingly enhanced. The iliofemoral is favorably located in respect to the above conditions.

We present the following case as illustrative of what is possible in dealing with some aneurisms of this vessel, and as suggestive of what occasionally may be accomplished elsewhere in the body.

W. C., colored laborer, age 49, admitted to surgical service Grady Hospital September 27, 1914. *Family history* uncertain. *Present history.* Some two months

[2] Halsted, W. S. The effect of ligation of the common iliac artery on the circulation and function of the lower extremity. Bull. Johns Hopkins Hospital, Vol. xxiii, 191.

[3] Halsted, W. S. Ann. Surg., Phila., lviii, 2.

[1] Read before the Southern Surgical and Gynecological Association, White Sulphur Springs, West Virginia, December, 1916.

ago noticed swelling in his right thigh a short distance below the groin. There was some little aching in the neighborhood of the swelling and numbness lower down the thigh. The patient frequently puts his hand on the swelling and feels throbbing.

Physical examination. Fairly well nourished, of good muscular development. On admission temperature was 98°, pulse 84. Temporal and radial vessels sclerosed. Posterior cervical, epitrochleor and inguinal lymphatics enlarged. Pupils equal, react to light and accommodation. Teeth in poor condition. Odor of pyorrhœa. Lungs normal to percussion and auscultation. Heart normal, apex in fifth interspace. The abdomen presents no peculiarities. Over the patient's back, and to a less extent elsewhere, the skin shows eruption characteristic of syphilis.

Beginning 6 centimeters below Poupart's ligament on the right in the course of the femoral artery, there is a rounded pulsating expansile enlargement. It has a diameter of 5 centimeters. Five centimeters below the lowest margin of the enlargement just mentioned, there is in the line of the artery an enlargement 3 centimeters in diameter, exhibiting expansile pulsation. Compression of the artery above stops pulsation and lessens size of swelling.

Treatment and progress. Antisyphilitic treatment was kept up for three weeks before operation.

October 31, 1914, a curved incision 10 centimeters long, convexity downward, uncovered the beginning of the right femoral artery, Poupart's ligament, and the lower external oblique aponeurosis for a little distance upward. Several inguinal glands were removed to clear the field. A flap of aponeurotic membrane 1 centimeter wide and 7.5 centimeters long (largely Poupart's ligament) immediately overlying the artery was dissected up, being left attached at its outer extremity. It was wound once around the artery and stitched back in place with just enough tension to obliterate pulsation in the vessel and in the aneurisms below. No. 1 chromic gut was used. The superficial epigastric was tied and cut. Bruising of the artery was carefully avoided. The overlying skin flap was stitched back in place. The right leg was ordered kept warm with hot water bottles.

November 2, 1914. There is no discomfort in leg. Seems the same temperature as opposite leg. Aneurismal sacs are easily felt, but exhibit no pulsation.

November 5, 1914. The aneurismal sacs are about the same size as immediately after operation; no pulsation.

November 12, 1914. The patient is up. There is no apparent disturbance of function in the leg. The aneurismal sac is decidedly smaller; no pulsation.

January 5, 1915. The patient returned to the hospital with a small skin sinus in the operative wound. A knot of catgut was removed. The swelling representing the aneurism can barely be palpated. The leg is in good condition. Antisyphilitic treatment has been continued.

June 12, 1915. There is no sign of aneurisms. There is some pulsation in Scarpa's triangle, but the area is quite smooth. No trouble is experienced in using the leg, but there is some numbness in the calf most of the time.

December 2, 1916. Function is good. The patient says there is some numbness and occasional aching in the calf of the leg, but he works every day. There is normal pulsation in the groin to a point slightly below Poupart's ligament. Beginning 5 centimeters below this latter point diminished pulsation in femoral line can be felt and followed further down the thigh, but there is no evidence of either aneurism.

The procedure outlined pulls the artery somewhat sharply forward out of its course. While we did not think erosion and hæmorrhage would occur we recognized it as a possibility.

Fig. 1. Drawing showing partial occlusion of primitive femoral artery with band of fascia from Poupart's ligament.

We also needed to know whether the vessel could be kept closed, or approximately closed, for such a length of time as would reasonably guarantee the cure of an aneurism.

We furthermore needed information as to whether such an approximate closure would frequently endanger the limb or seriously impair its function.

So far as the foregoing questions may be cleared up by using dogs for comparison we were able to get uniformly satisfactory answers.

1. We have occluded the femoral immediately below Poupart's ligament by a band of fascia as above described 24 times in 15 dogs. The dogs have been kept alive from 2 to 18 weeks, and in no instance has there been hæmorrhage. Furthermore, nearly all of these vessels have been examined at varying periods after occlusion, and it was evident that in no case was there danger of subsequent erosion.

2. Most of these vessels have been examined at periods varying from 4 to 16 weeks after being occluded to determine if the occlusion were still present. Without exception there has been a very much smaller artery below the constriction than in the other thigh used for comparison.

With great uniformity when the vessel has been uncovered above and below the constriction there has been the full pulsating external iliac apparently stopping flush with the occlusion, and below

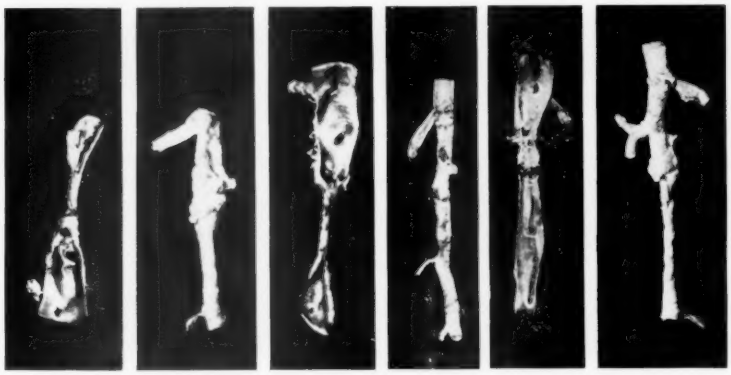

Fig. 2. Fig. 2. Fig. 3. Fig. 3. Fig. 4. Fig. 5.

Fig. 2. Showing occluded vessel before and after lumen had been opened.

Fig. 3. Also showing vessel before and after lumen had been opened. Complete occlusion.

Fig. 4. Apparent partial occlusion fourteen weeks after application of band.

Fig. 5. External appearance of occluding band fourteen weeks after application.

the band a cord which pulsated feebly or not at all until a point was reached corresponding to the giving off of the deep femoral.

3. It may be questioned very properly whether partial or total occlusion of the femoral in a dog jeopardizes the limb so much as a like procedure in man. Nevertheless we submit the information that in none of these 24 instances was there evidence of gangrene. We know that in a large percentage of these dogs the vessel was entirely occluded (see illustrations), whether immediately or gradually we do not know. Following the operation our notes show that the pulse could be palpated somewhere in the leg on an average on the tenth day. The earliest palpable pulse is recorded on the sixth day and the latest on the twenty-fourth day.

All the dogs were kept alive long enough for observation on loss of function. The average dog was lame for 5 to 6 days, but it is doubtful if this was anything more than soreness from the wound. A few were more or less lame for 2 to 3 weeks, but none of these failed to recover apparent normal use of the leg. We are not entirely convinced whether or not the bands when applied so as still to allow the passage of a small current of blood will cause a permanent closure of the vessel. In the first place in experimenting with small dogs, it is difficult for one to know with precision if he has or has not drawn the fascia to just the exact tension which will produce this result: in the second place a certain degree of relaxation probably always occurs. We know (see Fig. 3) that the band drawn snugly around the vessel effects a permanent closure either gradually or immediately, but we do not know beyond any doubt whatever that, through error, the band was not drawn too tight when applied.

During the earlier of these experiments we were more concerned with the problems of hæmorrhage from erosion and whether the band would constrict the vessel long enough than with the question of whether a band so applied would permanently occlude the vessel. We believe that permanent closure follows the application of the partly occluding band; but the number of our experiments and the attention we have given this feature do not at present justify the statement without qualification. We believe that in the vessels shown in the illustrations the closure was gradual. One photograph (Fig. 4) shows a vessel which was removed 14 weeks after application of the band. There seems to be a small lumen at and below the constriction, but the microscope shows that intimal proliferation is filling up the vessel.

Histologic examination of sections cut through the point of constriction shows the vessel wall embraced by fibrous tissue, which seems to be the fibrous tissue of Poupart's ligament itself. There would seem to be no reason to assume that it is a substitution for the band rather than the band itself. Indeed, microscopically, there is every evidence that the original tissue is in place. The band can practically always be traced outward from the vessel to blend with the aponeurosis: it cannot be identified and traced so uniformly to its inner attachment.

A SIMPLE AND EFFICIENT METHOD OF SUPRAPUBIC BLADDER SYPHONAGE

By NORMAN H. BEAL, M.D., F.A.C.S., London, Ontario
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ALL surgeons doing bladder work have at times difficulty in obtaining perfect bladder drainage. This is essential in keeping the wound and dressing dry, and the patient comfortable, also in keeping the space of Retzius free from urine, and thereby eliminating a serious source of sepsis.

For a time we have used the apparatus suggested by Dr. Bremmerman[1] and found the interval syphonage of great advantage. The following much simpler method suggested by Dr. D. H. Arnott can be set up without any special apparatus and works perfectly, doing away with the splash and giving a silent syphon:

[1] Dr. Bremmerman's Apparatus. Clinics John B. Murphy, vol. 5, No. 5.

A curved glass tube (*A*) is fixed by means of a small piece of rubber (*B*) or paraffin in a 6 or 8 ounce glass syringe (*C*) from which the plunger is removed. The end (*D*) should be cut on the bevel to allow the air to enter and break the column of water (a piece of rubber tube half an inch long with an inverted V cut in the side answers the same purpose). Water from the reservoir (*E*) is allowed to drop regulated by a screw clamp (*F*), into the syringe.

The flow can be regulated so that the syphon will run continuously, or at any given interval. We have found that five and one-half minutes keeps the dressing dry in the average case.

The Y tube (*G*) is, of course, below the level of the patient's body; (*H*) connects with the bladder drain.

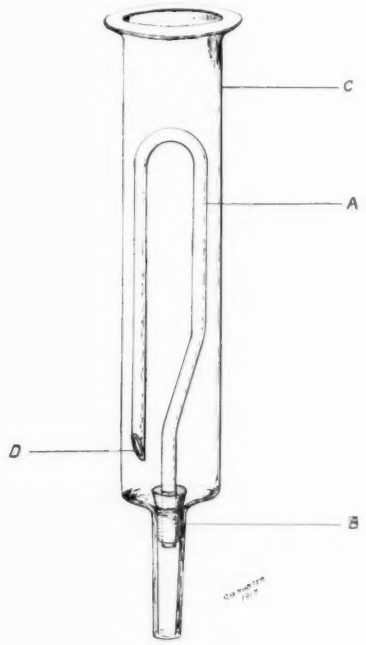


Fig. 1.

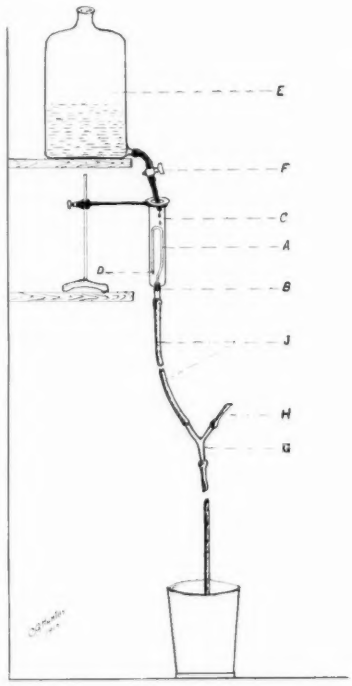


Fig. 2.

By using a reservoir that will hold several gallons (a 2-gallon demijohn will answer the purpose). The apparatus will run for 12 hours or longer without refilling.

The amount of urine passed by the patient can be determined by measuring the amount of water placed in the reservoir and deducting this from the amount of fluid found in the pail.

A SPLINT FOR THE TREATMENT AND TRANSPORTATION OF FRACTURES OF THE LOWER EXTREMITIES[1]

By CHARLES T. BUTLER, M.D., New York

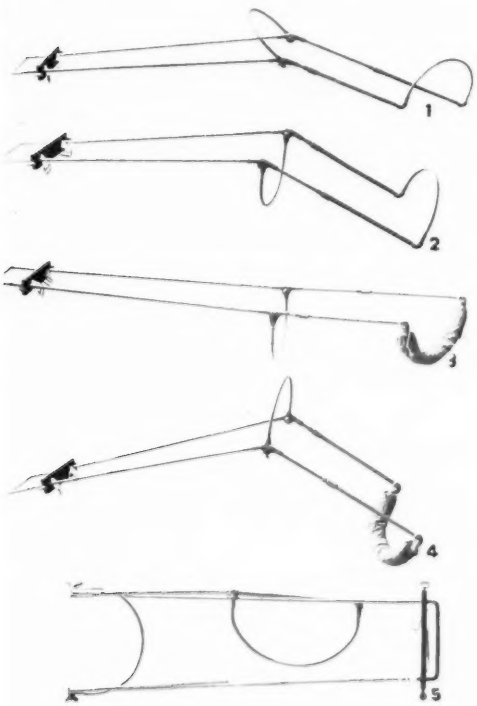
FROM June 10, 1916, to January 10, 1917, I had the opportunity, while located at the Military Base Hospital at Ris-Orangis, France, of which Dr. Joseph A. Blake was chief surgeon, of treating simple and compound fractures of the lower extremities with the Blake (a modified Thomas) and Hodgen splints, in connection with the balanced suspension method developed by Blake. The splints used were solid iron and it was necessary to have on hand left and right splints and different sizes of each, as well as Hodgen's splints with varying angles at the knee.

On my return to this country, I endeavored to incorporate the principles of these two splints in one apparatus and to introduce a joint at the knee. I endeavored too to produce at the same time a certain latitude of width at the knee and thigh and an adjustment of the thigh length.

The accompanying photographs will illustrate some of the various positions in which this splint may be used.

The position in Fig. 1 is that of a right Hodgen with spreader at the knee thrown forward.

In Fig. 2 the position of a left Hodgen has been obtained by shifting the relative position of the tubing; the near tube has been pulled away from, the far one pushed toward the center of the splint. Any desired position is rigidly maintained by a friction lock which is easily loosened by pushing the metal cuff with a spiral motion toward the center of the splint and tightened by the reverse motion. In this instance an additional width of one inch at the knee has been obtained by unscrewing the joint locks and placing the spreader inside instead of outside the joints. The spreader may be placed either above or below and in the latter position is much more convenient in cases where wounds of the anterior surface of the knee are present.



Figs. 1 to 5.

Fig. 6.

[1] Submitted for publication September 7, 1917.

Fig. 7. Illustrating one type of balanced suspension frame. The patient's leg is suspended in a left Hodgen's splint without extension. The trolley keeps the suspension weights perpendicular when the patient sits up or lies down. The cord, passing through the center pulley on the trolley, is tied to a strip of flannel or adhesive applied to the sole of the foot and prevents foot drop. The containers and main distributing tubes of the Carrel-Dakin treatment are shown here.

It may be noted here that the thigh *length* may be increased by drawing both tubes away from the knee-joint, and also that the thigh *width* may be made wider or narrower by altering the relative position of the sliding tubes. The width is greatest when the tubes are the same distance from the knee-joints.

To use the apparatus as a straight or Blake splint (Fig. 3) it is only necessary to pull off the tube section, turn it over, and replace it on the rods. A left or right Blake splint is obtained in the same way as described above for Hodgen's splint. A cushion of rubber cloth is laced on, as in this position the semicircular rod rests well up against the tuberosity of the ischium.

The spreader at the knee-joint is not absolutely essential when the splint is used straight, but gives additional support and is ready for use in case, at a later date, it seems advisable to bend the knee (Fig. 4). In the bent position the spreader is essential to insure strength.

The extension bar at the foot slides readily along the splint and may be fixed in any desired position by means of the set screws at the sides. To the buckles are attached the extension bands that have been fastened to the limb, and a knotted cord passed through the center hole runs over a pulley at the foot of the bed and is attached to the extension weights.

Figure 5 illustrates the splint folded (27x9x1½ inches).

Figure 6 shows the component parts of the apparatus.

Extension is maintained by means of mole-skin strips applied to the limb below the site of fracture or canton flannel strips held by Heussner's glue[1] or by an anklet, the ends in each case being attached to the buckles of the extension bar. Finochietto's stirrup or the Steinmann pin may also be used with this apparatus.

[1] Heussner's glue: colophene, 50; alcohol, 90 per cent, 50; terebenthene (Venician), 1; benzine, 10.

The limb is supported in the splint either by single double-faced muslin or canton flannel bands (from four to five inches wide and from fourteen to eighteen inches long), or better yet by one-half of an ordinary 3 or 4 tailed Scultetus binder. The latter method insures a uniform and smooth surface for the leg to rest in; is easily adjustable at any point, and prevents the skin from becoming ridged between adjacent bands as so often happens when the single ones are used. Double-faced rubber cloth is most satisfactory in the region of the wound, is quickly cleansed, and may be used repeatedly.

Ordinary spring paper clips about two inches long are extremely useful as a means of fastening the supporting bands to the splint. They never slip, are quickly and minutely adjusted, and there is no danger of infecting the fingers from pricks as sometimes happens when safety pins are employed.

The splint is used to best advantage with the balanced suspension method described by Blake (1) (Fig. 7). The advantages of this method of treating fractures of the lower extremities have been conclusively demonstrated in certain war hospitals in France, and the method is now being used to some extent in this country. The patient is infinitely more comfortable than when treated with plaster or Buck's extension. He can sit up in bed, lie down, or move from side to side at will. Wounds, if present, are easily dressed, and the technique of the Carrel-Dakin method of sterilizing infected wounds can be minutely carried out. Massage of toe, ankle, knee, and hip joints and effleurage of skin and muscle can be done, and above all, cleanliness can be constantly maintained. It has been found that wounds heal more rapidly; the consolidation of fractures is quicker and better, and the tone and spirit of the patient is kept at a higher level.

The splint may be used for the transportation of fractures of the lower extremities in the manner described by Blake (2). In the Blake position, the semicircular rod with cushion laced on is placed well up against the tuberosity of the ischium (as a fixed point) and prevented from slipping backward by a bandage across the front of the thigh. Extension bands attached to the limb, or the straps of the anklet, laced on over the shoe, are fastened to the buckles of the extension bar, and the latter is then extended to the required point, and held there by the set screws. The whole limb, well padded, is then bandaged in the splint. The splint, supporting and extending the fractured limb, may then be suspended by a spring from the roof of an ambulance or hospital train car, or

laid on a pillow. This method minimizes during transportation the danger of injury to muscles, nerves, and blood-vessels from sharp fragments of bone, aids drainage, and considerably lessens pain. Decubitus over the tuberosity of the ischium is prevented by discontinuing the extension for a short time, every forty-eight hours or so.

PRECAUTIONS

1. The splint should be kept on the same horizontal plane with the long bones.
2. When used as a Blake splint, the padded semicircular rod should be kept well up against the tuberosity of the ischium.
3. When used as a Hodgen's, the joint of the splint should always be kept opposite the knee-joint and the thigh length adjusted to meet requirements.
4. The flat side of the joint should always be placed upward and the tubing changed to meet the requirements of a Blake or Hodgen splint.

ADVANTAGES

1. It is adaptable for any fracture of either leg and as such may be used either as a left or right Hodgen or as a left or right Blake splint.
2. It can be used for transportation purposes.
3. Active and passive motion of the knee-joint may be begun early, thus decreasing the chance of adhesions, which must be later slowly broken down.
4. It is collapsible and easily packed.

I wish to thank Dr. Hugh Auchincloss for his valuable assistance in the perfection of the first apparatus.

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METHYLENE BLUE IN THE DIAGNOSIS OF ACUTE PERFORATING GASTRIC AND DUODENAL ULCERS

BY HILLIER L. BAKER, M.D., CHICAGO
Resident Physician, Cook County Hospital

THE diagnosis of acute, perforating gastric or duodenal ulcer in the absence of a good history is often extremely difficult. Indeed the diagnosis is frequently not made until the abdomen is opened. In reviewing the case histories of acute perforating ulcers occurring in the Cook County Hospital during the past six years, one is impressed with the frequency with which the pre-operative diagnosis of acute appendicitis was made. It has even happened that on opening the abdomen, the appendix has appeared markedly injected and covered with fibrin, and appendectomy has been performed and the peritoneal cavity closed, only to discover at autopsy that the real pathology was located higher up in the abdomen at the site of a solitary perforating duodenal or gastric ulcer. With this in mind it occurred to the author that by introducing some non-toxic coloring matter into the stomach before operation, the diagnosis of perforation might be greatly facilitated and the site of the lesion readily determined with the minimal amount of handling and traumatism of the viscera. The subsequent shock and the spreading of infection would also be greatly minimized.

The coloring matter chosen was medicinal methylene blue, a substance easily procured, readily soluble, and the color of which is easily detected and should not be mistaken for body fluids. The practical application of this method is well illustrated in the following case:

A. P., a colored male of 19 years and a cook by occupation was admitted to the Cook County Hospital, March 21, 1917, on the service of Dr. Wolfer. The examining room diagnosis was peritonitis. The patient stated that on March 21 at 9:00 a. m., he was seized with an attack of excruciating pain in the epigastrium. He vomited a greenish colored fluid. Severe and cramplike pains persisted in the epigastrium for several hours. Later the pain was referred to the lower right quadrant of the abdomen and has recently become generalized over the entire abdomen. No previous ulcer history could be elicited.

Physical examination revealed a young colored male apparently acutely ill. The abdomen presented a typical "board-like" rigidity and the bellies of the recti muscles stood out prominently. The rigidity is most marked on the right side. There are two definite tender points, one

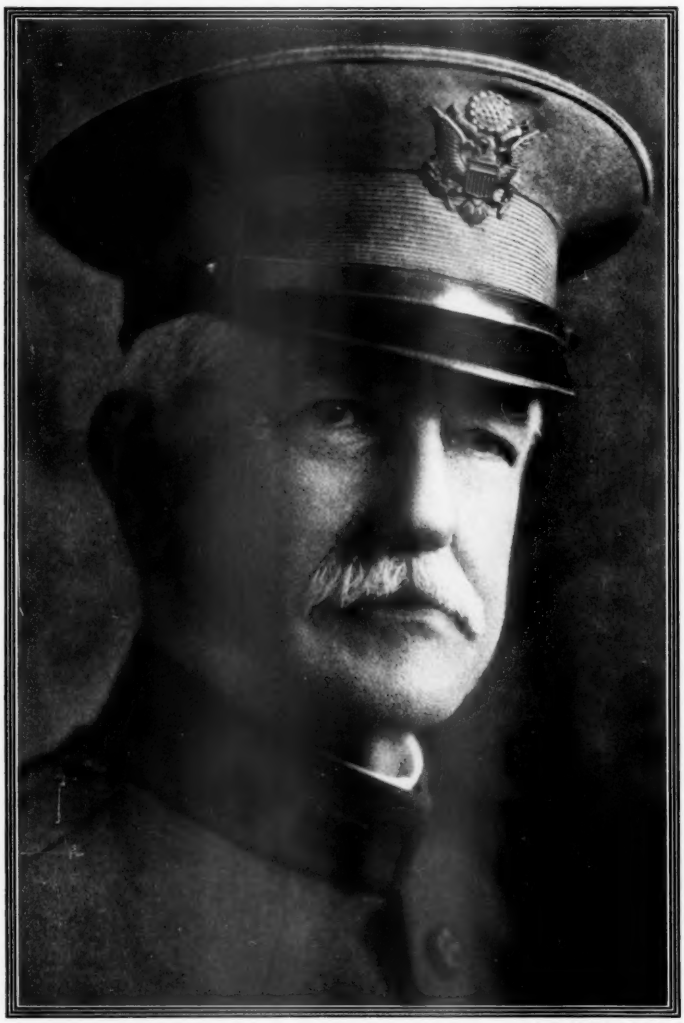
in the epigastric region to the right of the umbilicus and the second over McBurney's point. No dullness in the flanks. Rectal examination negative. Heart, lungs and extremities negative. The patient's temperature was subnormal — 98.2 degrees, pulse 70, and respiration 22 per minute. The urine contained albumin and hyaline casts. The white blood count was 15,000.

A tentative diagnosis of appendicitis was made and the probability of a ruptured gastric ulcer was strongly considered. Two hours before operation, the patient was given, by mouth, 3 grains of medicinal methylene blue dissolved in one ounce of water. At operation a right rectus incision was made over the appendix. The appendix was carefully examined and appeared quite normal. Accordingly, the operative incision was prolonged upward. The peritoneum was acutely inflamed and discolored, a bluish green hue. Traction was made on the greater curvature of the stomach, when a fine stream of bluish fluid was seen to spurt out through a small perforation on the anterior surface of the duodenum. The presence of the coloring matter in the stomach and its subsequent passage into the peritoneal cavity directed attention immediately to the site of perforation. The ulcer was repaired in the usual manner and the peritoneal cavity closed with drainage. Convalescence was uneventful until the sixth day when the pulse and respirations became accelerated, the patient talked irrationally, and had to be restrained in bed. Death occurred the same evening.

The autopsy was performed shortly after death, by Dr. John W. Nuzum. There was no peritonitis present. The ulcer was neatly repaired. The duodenum and adjacent tissues were covered with a thin layer of fibrinous exudate, a bluish green color. Death was due to a hypostatic bronchopneumonia of the dependent portions of both lungs. The anatomic diagnosis follows:

Solitary perforating ulcer of the first portion of the duodenum; recent surgical laparotomy incision; surgical repair of the duodenal ulcer; free clotted blood in the distal ileum; greenish discoloration of the mucous membrane lining of the stomach; fibrous adhesions between the anterior surface of the first portion of the duodenum and the inferior surface of the right lobe of the liver and between fundus of the gall-bladder and the hepatic flexure of the colon; early hypostatic bronchopneumonia of the dependent portions of both lungs; bilateral focal fibrous pleuritis; fatty changes in the liver and kidneys; cloudy swelling of myocardium; acute emaciation.

After reviewing the literature, I have been unable to find any reference to the use of bland coloring matter such as methylene blue as an aid in the diagnosis and localization of acute perforations of the stomach or bowel. The method is extremely simple, devoid of danger, and appears to possess several features of practical value. Chief among these are the ease and rapidity with which the diagnosis and site of perforation can be determined and with minimal amount of shock attendant on the handling of the viscera. The coloring solution should be given about thirty minutes to an hour before operation. The presence of the small amount of methylene blue in the fluid stomach contents which escape into the free peritoneal cavity will not increase the incidence of peritonitis and the advantages should overweigh any objection. A subsequent report will be made after a more extended trial of the above method in acute perforations of the gastro-intestinal tract.



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MAJOR GENERAL WILLIAM C. GORGAS
Surgeon General, United States Army

CLINICAL CONGRESS OF SURGEONS OF NORTH AMERICA

EIGHTH ANNUAL SESSION HELD IN CHICAGO, OCTOBER 22–26, 1917

SYMPOSIUM ON WAR SURGERY

TELEGRAM FROM PRESIDENT WILSON

My warm greetings and best wishes. It cheers us all to see thoughtful, patriotic work done in such a spirit.

WOODROW WILSON.

ADDRESS OF WELCOME

BY MAJOR A. J. OCHSNER, M.R.C., U.S.A.
Chairman, Committee on Arrangements

IN behalf of the surgical teachers of all branches in Chicago, I extend a hearty welcome to our visitors and to the members of the Clinical Congress of Surgeons of America.

For several years the leading spirits of this Congress and the officers of the American College of Surgeons have quietly exerted their efforts toward the formation of plans for the standardization of American hospitals, which culminated in a splendid conference just concluded in which many of you have participated.

The men here assembled tonight are most active in the conduct of American hospitals and most deeply interested in obtaining a high degree of efficiency in these institutions. With your enthusiastic support and your active personal participation, it will soon be possible for practically all hospitals in this country to achieve a standard far above the maximum that could have been demanded only a few years ago.

We have no desire to place a few hospitals on pedestals and to brand a large number of struggling institutions as hopelessly inefficient, because such a plan would ultimately do far more harm than good. Neither do we desire to limit progress by a plan of standardization. Centuries ago China standardized her industries and professional activities, including medicine, and we all know what the results have been.

With reasonable planning and widespread personal attention and publicity, it seems possible to stimulate practically all hospitals in this country to overcome what defects there may exist in their organization, so that soon each one will excel in efficiency the best hospitals of today.

During past sessions, this Congress has unconsciously done the profession of this country another great service. It has given a group of the younger clinical teachers an opportunity to demonstrate their claim to recognition as honest, industrious, capable, and painstaking scientific workers in the field of surgery.

No group of men is quicker to recognize merit than the men who attend this Congress from year to year, nor more ready to relegate to oblivion the professor who imposes, year after year, the fruits of his indolence and arrogance upon his unsuspecting undergraduate students. Clinical teachers are in need of standardization quite as much as hospitals, and you can be depended upon to do this service.

Above all things, however, we will count upon you to take an active part personally in furthering the wonderful work that is being done by the Surgeon General of the United States Army and those who are earnestly assisting him as his aids. His wisdom and skill have been the means of saving more human lives in the past than it is possible for any one to conceive.

He has the splendid support of such distinguished men serving this country as the Surgeons General of the Navy and the Public Health Service, and of all the men who have been at the front and who will speak to you tonight.

The most important present duty for every member of this Congress consists in determining

in what way he can be of the greatest possible assistance to our Surgeon General.

There is no doubt but what this country could have built the Panama Canal without the work of Surgeon General Gorgas, supported by the medical profession of this country, but we can be very certain that this would have been done at the expense of hundreds of thousands of lives, and that at the present critical time this country would not be able to use its naval forces on both sides of this continent because a transfer around South America would be out of the question.

This country is certain to win the war in any case, but your efficient support of our Surgeon General will mean a shorter war and the saving of lives of many thousands of the splendid young men who are now preparing for service.

The reason why your service will be so valuable is not only because of your enthusiasm and ability, but because you stand for surgery that is not only surgically clean, but ethically, intellectually, and morally clean. With this support our young men will go to the front in the best physical, intellectual, and moral condition. They will bear their hardships well, and those who are wounded will receive such prompt and efficient treatment that their ultimate misfortunes will be as slight as human skill and earnest effort can safeguard.

Our leaders, and among them especially Surgeon General Gorgas and Dr. Franklin Martin, have shouldered the task of organizing thousands of medical men into an efficient working force which never before has been equaled in this country in the field of military surgery. The benefits to our country resulting from their efforts will exceed our wildest imagination, and it is the great privilege of the members of this Congress to assist them in this magnificent work.

I welcome all of you to a week of activity full of inspiration and practical, productive patriotism.

THE SURGERY OF THE WAR AND THE PART PLAYED THEREIN BY AMERICAN SURGEONS

By Major F. B. LUND, M.R.C., U.S.A.

THE day of the individual has past. The war has seen to that. It is at once the duty and the privilege of the medical profession of these United States, united now against the German menace, to serve the Government. The profession has responded nobly to the task, and enrolled now in the Medical Reserve Corps are about fourteen thousand physicians. We need twenty-two thousand, and we shall get them without a medical draft. The patriotism of the profession can be counted on.

After two years of patient endurance of the arrogance, insolence, and intrigue of Germany, our President and Congress decided that our country should be enrolled in the real league to enforce peace, and take its place with those allies who are united in the holy bond of this inexorable purpose. We are in the throes of tremendous preparation, material and moral. Our time, money, and earnest endeavor are being organized with a serious and indomitable effort. We have hardly begun to scratch the surface of the field, and of all the times in history, this is the last on which we ought to congratulate ourselves on what we are *going* to do. Until Germany has been defeated, and we have had in that defeat our part have we any right to point with pride. Our only purpose should be now, realizing the magnitude of our task, to work the harder to make our belated efforts tell. In the homely phrase of our countryside, we must say nothing and saw wood. And yet we may be proud that the medical profession, even before our Government had entered the war, gave of the very flower of its ranks in the aid of the allies. Since the spring of 1915, the American Hospital at Neuilly has been covered, first, by the Cleveland Unit under Crile, then by the Harvard Unit under Cushing and Greenough, and, since the summer of 1915, by Hutchinson of Philadelphia. Nor should we forget Joseph Blake of New York, who has given longer and more arduous service to the French than any other.

In the spring of 1915, the Northwestern University Unit, in charge of Dr. Neff, left for service with the British at Etaples. The organizer of this unit was the late Dr. John B. Murphy of Chicago: John B. Murphy, that most brilliant and sagacious surgeon, teacher unsurpassed, founder and supporter of this organization.

Since 1915, Harvard has officered a base hospital near Boulogne, under the lead successively of E. H. Nichols, Faulkner, Cheever, and Jones; until in February 1916, three months before we began hostilities, Hugh Cabot took charge for the remainder of the war.

At once upon our entrance into the war, the Cleveland Unit left again, under the Stars and Stripes this time, and was followed almost immediately by the second Harvard Unit, organized by Cushing; the Northwestern of Chicago, by Besley; the St. Louis, by Murphy; the Johns Hopkins, by Finney; Columbia, New York, by Brewer; and the Massachusetts General, by Lincoln Davis; the Roosevelt, by Peck. Nearly thirty other Red Cross units have been organized and are ready to leave at once when called.

Two members of the medical service have been the first of our combatant forces to have the honor of giving their lives for their country. Lieutenant Fitzsimmons of Kansas City, a member of the Sec-

ond Harvard Unit; and Lieutenant Howe of Boston, who was killed in field service with the British Army. He was the first member of the American Army to be killed in battle; surgeon, intrepid explorer, scholar, officer, and gentleman, he could not have asked a better death.

The Surgeon General's office is a seat of activity on a tremendous scale. Our President, realizing the importance of the part the medical profession must play in this enormous task, has appointed a medical member of the Council of National Defence — none other than the honored secretary and I may say, founder of this association and of the American College of Surgeons, Dr. Franklin Martin. His vision, courage, and executive skill made possible these organizations, and have found fitting recognition in the important part he is playing in the medical side of the war. As a member of the Council of National Defense and chairman of the General Medical Board, he has more than justified, by his untiring and successful efforts, the high honor to which his merits have raised him.

The Surgeons General of the Army and Navy, faced with the enormous and, what to a military man, must have seemed an impossible task of fitting civilian physicians into the expanded military machine, have acted with a breadth of vision, courtesy, and fairness, in an effort to put each man where he would do the most good, which has excited the wondering admiration of all. If we of the rank and file but render our services in the same spirit, our part in the war will be a proud one. When we hesitate to leave our practice and the places we have established in the community, and for the brilliant results of civil work, exchange the tedious care of the shattered bones and dirt-infected wounds of this war; we must remember that the wounded men have sacrificed not only their professions but their lives, their health, their all.

If discouraged by the nature of the work, let us think of Carrel, that wizard of technique, who gave up his life of scientific achievement to take care of "those poor bundles of mud and blood we call wounded soldiers," and by the application of the same qualities to the new problem which he had brought to the old, has made a real contribution to surgery and humanity. At the very outbreak of the war, he "turned a keen untroubled face home to the instant need of things." He has set us a noble example. And so have Brewer, Finney, Crile, and others. Let us do our part.

The world can get on just now with the surgery of peace developed to the point which it had reached when the holocaust began, and to which American surgeons have done so much to bring it. If we do not do our war duty now, the country at peace will be a poor place to live in; and above all, we shall be compelled to live the rest of our lives knowing that in the supreme need we shrank from duty. As the war has thrown civilization back to the earlier state of barbarism, so surgery has been thrown back from the aseptic to the antiseptic period, with all that that implies. We may not like it, indeed, but it is not what we like, but what meets the need, that we must do, and so do with all the zeal and skill that we can bring to bear.

To the older of us, the war has brought the priceless opportunity of doing before we die something really unselfish. The day of the young man in medicine has come, and what would we older men give to be starting in practice now, at this very moment of the world's history? Dark and doubtful as the future must sometimes look, clouded by the storms of shot and shell, saddened by starvation, mutilation, and the suffering of the innocent, still here is our glorious opportunity. We have the privilege to help put an end to this horrible nightmare that hovers over the bosom of the once fair earth. We must and we will.

For the lies the Hun has spoken,
For the scrap of paper, torn,
For the ancient treaties broken,
For the solemn oaths, foresworn,

For little children, lying dead
Beneath the ocean deep,
For the coward shot their souls that sped
To their eternal sleep,

For the sack of the Belgian cities
By murder, rape, and fire,
For the maidens' honor sacrificed
To slake the Hun's desire,

For our boys in the sunny fields of France,
Who were not afraid to die,
For the little wooden crosses,
That mark them where they lie,

For the blood that flowed on the desert road
By Tigris' swollen flood,
For the sweat and stench of the shell-torn trench
In Flanders' rain and mud,

For the men that have died on the mountain side,
Where Italy's brave sons
Hurled backward from their rocks and crags
The onslaught of the Huns.

When mother, England, sister, France
Are battling for the right,
And the thin line wavers, help us God!
What can we do but fight!

And so for England and for France
Let Yankee cannon roar,
Till God's blue sky be blackened
By cannon smoke, no more!

NEW SURGICAL PROBLEMS DUE TO THE WAR

By JOHN G. CLARK, M.D.
President-Elect.

BECAUSE of the world's titantic upheaval, in which almost all of the North and some of the South American countries are now participating, the entire trend of surgery upon this side of the Atlantic has been diverted from the consideration of everyday clinical problems to those urgently brought into the foreground by war. From professional attendants in civil life, thousands of physicians in the United States under the tutelage and guidance of our efficient army and naval medical services will take up their march behind the Chariot of Mars. Because of this transfer of professional interests from those of civil life to the emergency call to military duty, the plan of previous Congressional transactions has been changed and your executive committee has wisely set aside the programmes of three evenings for the consideration of military and naval subjects. In deference to this variation from customary procedure, the presidential address will find its place in the programme devoted to clinical topics on Wednesday evening, and it becomes my pleasure this evening to sit as an auditor in this assemblage of distinguished speakers, who are intensively devoting their work to military affairs. They stand as our leaders, not in the ranks of the warriors but in the humane science, which deals with salvage rather than with destruction. They are concentrating their efforts upon camp sanitation and medical prophylaxis, two phases of medicine, which under the discoveries of this generation, and through their application and adaptation to the immediate stress of war, have contributed many health measures which are said to have saved already more lives by warding off disease than were destroyed by all of Napoleon's armies. Soldiers suffering frightful wounds are quickly healed and are returned in full efficiency to their duties. Life-saving methods have been devised already and others are forecasted for the near future, which may revolutionize the practice of civil surgery after this war is over. Medicine, therefore, will come out of this destructive era far richer than it entered it. The great Nélaton announced that the discoverer of a method of controlling suppurations would deserve a golden statue. If that brilliant Napoleonic surgeon could be reincarnated and could walk the wards of the military hospitals of France, he would see the most magical changes in the treatment of injuries.

This evening we are to hear from the distinguished Surgeons General of the Army, of the Navy and of the Public Health Service, and from our honored surgical ambassadors from the offices of the Surgeon General of Great Britain and France. In reviewing the phases of the colossal task of welding into efficiency a wonderful surgical machine, the parts of which were gathered out of the onrushing chaos of the early days of this war, we stand in profound admiration, especially when we realize what astounding results the British and French surgeons have accomplished in so brief a period and in the face of such discouraging and almost insuperable obstacles. Through the profound wisdom of our great executive, President Wilson, a Council of National Defense was created some time before the actual announcement of the existence of a state of war by our government, and for the first time in our history, medicine was given a ranking position in a distinguished national body. Men of rare skill and preparation for their duties were chosen from civil life to occupy the chairs about this council table. From more than 140,000 doctors of the United States, our President had a wide range for selection of his medical adviser, for within our nation there is a large number of brilliant physicians and surgeons, many of whom possess unique executive capacity. In the plunge of a great nation from a pacific state into the terrible vortex of modern warfare, organizers of rare ability are the first essential. Many names were considered and out of this number a man was chosen who had created a great American surgical journal; had conceived, promoted and fashioned this unique annual gathering of American continental surgeons for clinical advancement; and finally, as a capstone, had founded the American College of Surgeons, which has for its object the standardization and elevation of the practice of surgery. To Dr. Franklin Martin, who has had the penetrating vision to see beyond his time, we are all deeply indebted for his contributions of epoch-making ideas and for the energy to put them into force.

It is with keen regret that I announce that Dr. Franklin Martin, because of illness, is prevented from taking his place on our programme, but with his excellent executive foresight he has prepared a very happy surprise for you: through his invitation, Mr. Daniels, the Secretary of the Navy, honors us with his gracious presence this evening.

Two phases of the Honorable Secretary's administration of his high office have a very vital bearing upon the health and moral welfare of our sailors. First, he abolished alcohol from our ships and naval reservations, and second, established well-planned restrictive and educational measures for the purpose of shielding the young men of the Navy from the great venereal peril, thus reducing two evils, which strike at the very foundation of health, efficiency, and manly character.

To Secretary Daniels, therefore, we, as a Clinical Congress of Surgeons, offer our cordial commendation of his most worthy attitude and pledge to him our allegiance in his great work.

THE PHYSICIAN'S GREAT PROBLEM IN THE WAR

By Hon. JOSEPHUS DANIELS
Secretary of the Navy

As I was leaving Washington, a friend, intimate enough to speak with frankness, said that he could well understand how I could invite myself to come to Chicago and get an audience of 15,000 young sailors at the Great Lakes, because under military service regulations they were compelled to attend and hear me; but he could not imagine how I could obtain an invitation to speak before the most distinguished body of surgeons in the world. Well, I told him I thought he ought to know me well enough to know that knowledge of a subject was an embarrassment, and that the only man who could speak well on a subject was the man who had no embarrassment of knowledge, that really the reason I had been invited was because I had suffered many things of many physicians.

Frankly, I was ordered here by Dr. Martin and the Surgeon General of the Navy, and if I always had such assignments, I would be willing to have them assign me every day in the year.

It is a great privilege to speak, therefore, as one who has always honored the profession, in this presence. It was gratifying to hear both of your speakers refer as they have done to the distinguished services of my distinguished friends, Dr. Gorgas, Dr. Rupert Blue, and the Surgeon General of the Navy, my warm friend, Dr. Braisted. I feel we ought to say to each one of them what the great city surgeon said to William McLure, "You are an honor to your profession."

Charles Read never gave us anything so interesting and so helpful as his picture of the physician in "Put Yourself in His Place"; and I love to think of what the young man said to Dr. Amboyne: "Talking to you is like drinking sunshine"; for you have that in your power not only by healing and the knife to carry into homes sunshine and cheer, and health and strength and life, you have that in times of peace. In times of war it is to the physician that the nation turns with supreme confidence in the belief that in preventive measures we may save the lives of the youths who are hurrying to the standards.

So much has been done in preventive medicine that no longer in the Army and Navy do we fear that scourge of typhoid fever. It is almost negligible; and the skill of the men of this profession is lessening the danger of other diseases.

And with the advent of battle and the certainty that our country will have to pay its toll, there is no finer spectacle of unselfish service, worthy of the disciples of the Great Physician, than hundreds and thousands of doctors and surgeons in our country who have enlisted, who have volunteered in the Army and Navy, going over to France, ready to prevent disease by sanitation and wise counsel and medical skill and to bind up the wounds and repair men who have been shattered and to make them again useful members of society.

Tonight, speaking for myself and the Secretary of War and for our great leader President Wilson, I wish to express the thanks of America to you gentlemen who are making these great sacrifices.

I know of physicians and surgeons giving up practices that are most valuable, tearing themselves away from associations most tender, donning uniform, and giving themselves to a service that is essential to this great war upon which we have entered. They have no illusions about war. They know its toll.

Before America declared its participation in this worldwide war and gave notice to the world that the doctrines of force and divine right and ruthlessness should forever end, these physicians were already succoring those who needed their help. And since they have come to us ready, not to be trained, we do not have to put them in training camps. They come as did the officers and men of the torpedo boat destroyers which we sent to England. You will recall the thrill that went over the world when the first installment of destroyers, unannounced and unheralded, reached port over there — I am not permitted to say where, because of the rules and regulations. But when the destroyers came into port and were met by the British Admiral, he said to the ranking officer: "When will you be ready for service?" And this young naval officer, animated by the same spirit which animated John Paul Jones and Decatur and Dewey, said: "We are ready now."

So these surgeons and physicians, going into the national service, have no waiting time. They come and say, "We are ready now." And in our camps and cantonments which are being prepared, they have given their counsel and advice, so that the best sanitation may be adopted and hospitals may be erected.

This morning, or rather last night, at the Great Lakes Training Station, here virtually in your own city — the largest naval training station in the world, and the best, in company with the Surgeon General of the Navy, I visited the units, the new temporary hospitals there, where we have installed the latest and most approved system to care for our men who are ill; and I paused as we passed through the wards to speak to the lads who were in those hospitals and to talk with them; and without exception they were cheerful. Every one of them said he felt better and was thankful that a grateful country would see to it that if they were ill or wounded, not a thought of money would be considered in caring for them.

I wish to speak to you tonight and call you to a

high service which no other men in America can render. Too long we have had a conspiracy of silence about the most festering evil that touches American youth. The day has come, the hour has struck, when the prudery which has made us shut our eyes to the destruction of youth should demand that we shall quit lying and tell the truth.

We have now over a million men under arms, and we shall soon have ten millions. If need be, to win this war we will call to arms every man under fifty and if it should chance that they may not win the victory, then we will rob the cradle and the grave, because liberty and equality, and government by the governed shall not perish from the earth.

We are appealing to the manufacturers to turn out cannon and guns and ships and torpedoes, and they are responding. We are appealing to skilled mechanics throughout America to do their level best to provide the implements of warfare, and I want to say here tonight that the response of skilled mechanics in America has heartened and cheered every man in official life in Washington and every good citizen in America.

The whole of America is mobilized. The few who a month ago seemed not to be thoroughly American have either been sent to jail or will have been sent there. But I am thankful to say and proud to know that in America the number, as numbers go, is almost negligible, and though the strong arm of the Government is raised, and though the various departments have a secret service that permeates every nook and corner of America, you can count by the hundreds those who have been caught red-handed in treason. And America is united, more so on this proposition to win this war at the cost of the last man and the last dollar, than it ever was on any proposition in the history of our country.

But we cannot win this war without soldiers and sailors with steady nerves and clear heads, and men do not have steady nerves and clear heads unless they live straight lives. If anything on earth should cause me to doubt the goodness of God, it would be that he had given to mere boys the passions of manhood without the restraints of manhood.

Ten million men are going out to fight the battle of righteousness. And how are they clothed and what environment do we place them in? We talk about battleships. They are mere junk unless we have trained men and skilled men to man them. You put ten million men under arms and let a portion of those men be diseased and make no check on the immoral surroundings that we place them in, and the nation is unjust and unfair to those men and to itself.

For the first time in the history of the world our country has started on a new line. We have recognized the evil. We have no longer whispered about it in back rooms and have put poultices on the evil and tried to hide it, when it lifted its head, but we have said: "Let the sunlight come upon the diseases of immorality and let us appeal to young men to be clean in body as well as in soul."

The peril today is not merely the German guns. Lloyd-George said that England had two enemies: the Germans and drink, and drink was the most dangerous of the two.

I tell you tonight, there are a million fathers and mothers in America who are willing to make the sacrifice to send their boys to the front and jeopardize their lives, who are more afraid that their bodies will be tainted and that they will come back diseased through immorality than from German bullets.

It is a terrible menace. The diseases from immoral life are more deadly than tuberculosis, more deadly than cancer, than yellow fever; and Dr. Osler says, of all diseases that destroy manhood, that destroy homes, that bring children into the world weak and puny and diseased, is the disease that comes from young men who are not moral and straight in their lives. That is the menace.

There comes news from Vienna, from General Hecht, that three divisions of Austrian soldiers are out of fighting because of venereal disease. Seventy-eight thousand men in the English Army are impotent and put out of battle because of immoral disease. A little handful of Germans in Belgium have furnished 35,000 cases. What shall we do, members of the profession, with these young men sent to the front?

The Congress of the United States has passed a law and put it in the hands of officials, to carry forward measures more drastic than ever dreamed of before. It is not only abroad that this pestilence walks by day and destroys by night. It is in our own Navy, it is in our own Army, it is in our own civilian life. Think of it! During the last fiscal year, because of the diseases caused by sin, 141,000 days were lost in the service of the Navy; 460 men were incapacitated; and if you add to them the number of men who have to nurse them and care for them, a whole battleship crew was taken out of the Navy because of this disease. One person in every 112 in the Navy had to be treated, and almost as many in the Army.

Let us quit trying to use a poultice when we need the surgeon's knife. Let us recognize that this evil not only menaces the Army and Navy, thus menacing national defense, but it menaces every home; and I came here tonight, Mr. President and Gentlemen, to appeal to the only men in America who can educate the people and compel a hearing. It is up to you gentlemen of the medical profession, whether this evil is so presented to you men, is so emphasized, that it shall be lessened.

When a minister of the Gospel preaches against this, the young men think it is professional in the minister to tell them to be good and to keep clean lives. But when the physician, who brings us into the world and who closes our eyes in death and who takes care of our bodies, when he speaks men hear him who turn a deaf ear to every other admonition. Therefore, speaking for efficiency in the Army and in the Navy, for I have no right to speak for the

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ADMIRAL WILLIAM C. BRAISTED
Surgeon General, United States Navy

civilian population any more than you have, I appeal to the physicians here and throughout America so to educate the youth of this country that we may stamp out this menace, that we may have a youth, clean in body, clean in mind, and clean in thought.

I speak to you with the seriousness and solemnity of one who has seen its ills in the service, and out of the serivce, and because I am profoundly convinced if the medical profession of America would stamp out the lie that it is an unpreventable and necessary evil and convince young men that continence is the only safety, we would eradicate this evil and make our young men all that their fathers and mothers wish them to be. Today, as never before, American manhood must be clean. We must have fitness. America stands in need of every ounce of strength.

Gentlemen of the profession, we must cut out the cancer if we would live!

THE SURGEONS' RESPONSE TO THE NATION'S CALL

By Surgeon General WILLIAM C. GORGAS, U.S.A.

A CONSIDERABLE proportion of the audience that I address are members of the Army Medical Corps and I will speak therefore to them principally as Surgeon General.

One of the speakers this evening has been kind enough to refer to certain incidents of the past life of the Surgeon General in a very complimentary way. I was, however, disappointed that he did not call attention to what seems to me a considerable job in my present life. There is not a man in the community who is not sure that he is just as good as anybody else in the community and perhaps a great deal better than the doctor.

Now, I have been accustomed to manage, as Surgeon General of the Army, a small number of doctors. We had gotten along pretty well because they had been used to this style of management for a number of years. I looked forward with considerable dread to the great addition which has occurred to the Army Medical Corps on account of the war, and knowing this quality of the Doctor so well I expected to have considerable trouble in the management. But so far no great difficulty has occurred.

Now, I think this fact, that the present Surgeon General has managed to get along for six months with 14,000 doctors, without any great trouble, ought to be mentioned in the eulogies which have just been called to the attention of this office with regard to the present Surgeon General. I hope the next time I come to Chicago that this error may be corrected.

Our nation is in the most important war in which it has ever been engaged and probably in which it ever will be engaged, and we are fighting for the greatest principle for which we ever fought; that is the freedom of the world. It seems to me, as we look back six months that we must acknowledge that the nation has responded most nobly in all its branches in every way.

I do not think anybody six months ago could have looked forward and expected the whole nation would have roused itself as it has, and that we would as a nation have accomplished as much as we have at the present time. But I think, without belittling any other section of the nation, that our profession can claim pre-eminence. There is no part of the nation that has responded to such a degree, to such a great extent, as the profession of medicine. It has been found that no other part of the nation has responded more promptly and in such a proportion of its number, as the medical profession has been called upon to do; but at the same time I think it perfectly fair and just for us to point out to our fellow country-men that we have measured up to all the requirements so far that have come to the profession.

There is no member of the profession in the United States that has assisted the office of the Surgeon General as much as these great societies, one of which I am now addressing.

I wish, therefore, as Surgeon General of the Army and as the representative in that capacity of our administration, to thank this association for the help which they have given us and I hope to thank them again for more help.

THE NATIONAL BOARD OF MEDICAL EXAMINERS

By Surgeon General WILLIAM C. BRAISTED, U.S.N.

THIS would seem to be a fit occasion to refer to the activities of the National Board of Medical Examiners of which I have the honor to be the presiding officer.

When the board was originally planned, its purpose aimed at offering an examination which would be a test of qualified applicants, through which a group of experienced teachers in the federal services and in civil institutions might determine the knowledge of candidates by rigid test, through which they might be certified as acceptable for the Corps of the Army and the Navy and for license in the United States and its extraterritorial possessions. The character of the examinations, written, oral, and practical in laboratory methods has already been extensively reported and discussed. The quality of the examination has been recognized through the acceptance of the written papers of those successful candidates who have applied for the federal services and further by the announcement that the Mayo Foundation in the University of Minnesota would receive such licentiates of the National Board as fellows, without further requirements. The board has pursued its object with steady intent and has held three examinations, with a total of 50 applicants, of whom 36 have successfully passed.

After the conclusion of its June examination, the members of the board seriously deliberated the advisability of suspending all examinations during the period of the war. There seemed, however, to be a plain duty of service for the board to perform. As its creation contemplated as one of its main objects, the preparation of men for the Army, the Navy and, in time, for the Public Health Service and as each of these national departments needed men in their regular corps, the board concluded not only to go on with the examinations but to conduct them more often and to arrange to go to the larger cities to bring the examinations to the internes in the greater hospitals. An examination has just been concluded at Chicago, with 29 candidates. In January, an examination will be held in New York.

Not only does the examination of this board aid largely in the development of material for the federal services, but it additionally provides for the future adjustment of the men who are candidates for these services. No one may say how long the war will last. Young men going into the services of the Army and the Navy, or in the Reserve Corps of either, at the end of the war, retired from military duty, have to decide upon a location for their civil practice. Already a number of states have indicated their intention of accepting the licentiates of this board upon registration and without further requirement. Other states have legislation pending to satisfy the legal requirements covering a like privilege.

The fact that 6 of the 15 members of the board are in the regular service of the Army, the Navy, and the Public Health Service, and others are in the Medical Reserve Corps makes it desirable that the work of the board in relation to the present war conditions should be accentuated. It may serve a wider purpose if authorized.

There are several thousand medical men in the training camps and more will come. At the conclusion of the present hospital year, or by July of 1918, many internes of hospitals, now in the Medical Enlisted Reserve, will be assigned to active duty. The task of examining these young men in camp and those on the way will be delegated to some boards already active in the work for the Medical Reserve Corps. There will be many who would likely desire to go into the regular corps and who have the qualifications required by this board for its examination. By an early provision for the examination of the internes who are already on *inactive* military duty, this board might arrange to examine all qualified internes before they go on *active* duty. Through the direction and with the co-operation of the Medical Departments of the Army, internes might be ordered to report for such examinations and, in this manner, the Medical Departments of the Army and the Navy could be relieved of a number of stated examinations and could conserve the time of regular examiners, needed for other duty, particularly as both of these services are already well represented on the Board. As a matter of fact, with so large a number of the board either in the regular Corps or in the Medical Reserve Corps, this board may be construed as being a quasi-medical Board for the services, only needing the authority to proceed.

The board has a particular value to the services, as well as to medical education, in that, from the beginning, it has stressed the importance of laboratory tests in bacteriology and in clinical medicine, besides the practical clinical examinations in surgery and in medicine. If its operation is assured by the support of medical school faculties and by the profession at large, it may, through the advice of those in authority, increase its usefulness as time gones on. With the standardization of medical education, of public health methods, of hospitals, and their correlated activities, there must be some standard for testing the qualifications of those men who are coming on to take charge of the problems which the future will bring.

By undertaking examinations at different great centers, this board, co-operating with the faculties of the leading medical schools, will, ultimately,

extend its operation until it may reach a standard, and that the standard at which it aims.

The test of the graduates of the best schools and the best hospitals will, perhaps, afford some criterion and the work of the board may point the way to a co-ordination of the Federal Services into a combined educational unit. Already the suggestion has come that the opportunity be afforded for young men to train for a medical military career. This Board, which has successfully united the three federal medical services in a harmonious body working for altruistic standards for these services and for medical education generally, may point the way to a *United Service Medical School* — a medical West Point or Annapolis — at which men may qualify for medical military service, after a training which will fit them, under exceptional conditions, for such a career.

NATION-WIDE MOVEMENT TO PREVENT DISEASE

By Surgeon General RUPERT BLUE, U.S.P.H.S.

THIS is the time for the estimation of values. Individually and collectively we are making many sacrifices. Every energy of the American people is concentrated upon the winning of the war. We feel that everything that leads to efficiency brings us nearer victory. Therefore, with thankfulness I announce to you that the health of the United States is in better condition today than ever before. There has been an awakening of the consciousness of our American people. In the areas around the cantonments, the state and municipal governments have joined hands in the prevention of disease. The water and food supplies, the medical inspection of schools, the control of communicable diseases, all have been placed upon a good basis. More than 75,000 Americans have voluntarily taken the typhoid inoculation. The extensive mosquito breeding areas have been practically rendered free from malaria. Thousands of rural homes have been provided with sanitary conveniences. The cantonment zones are gradually being extended; just as a stone thrown into a pool throws a wave to the furthermost shore, so it is hoped that this work, intensified by the stern realities of the war, will finally spread to the farther corners of the country. Disease is being turned back from our shores by the emigration officials. Research is tracking infection to its lair and providing new methods for its control. There is a nation-wide movement for the prevention of disease. This is not accomplished by any one set of persons, but by the American people. Health agencies could not have accomplished it, no authority or propaganda could have attained this end. We are an intensely practical people and have to be shown before we will believe. In the days of peace it was almost impossible to convince the average American of the necessity of national hygiene, but when we were forced into war, when it became immediately obvious to all of us that we must fight, there came the knowledge that these sanitary measures must be followed, and out of this war will come a better, stronger, and more enduring national health.

CO-OPERATION OF BRITISH AND AMERICAN MEDICAL CORPS

By Colonel T. H. GOODWIN

Representative of the Director General, British Army Medical Service.

I WISH very much that I could adequately express to you my appreciation of the honor which has been accorded me this evening in the invitation to be here as a guest of this Congress. I only ask you to believe that I appreciate it very fully and very keenly.

The medical profession of this country and of Great Britain has for many years past been closely united in ties of social and professional friendship. The services of the armies and navies of both these countries have for very many years, whenever they have met and in whatever part of the globe they have served together, they have met in a spirit of the closest amity and comradeship.

During many years' experience and service abroad I have come across innumerable instances of this. I remember several years ago, when at a foreign station one afternoon I met one of our naval officers, and he said to me, "An American warship has just come in, and I am afraid we shall have trouble tonight." I was, of course, very much surprised and indeed astonished at this, and I am afraid rather horrified; and he gave as his reason: "You see whenever the American sailors and ours meet they immediately join together and proceed to tear up the town." And he added "And they do it most effectually."

It has always seemed to me, and recently even more so, that if they can do effectual teamwork in play, they will do even more effectual teamwork in war.

The services of the two nations are now fighting side by side with a common object, with identical

ideals and with the certain expectation of mutually attained victory in the future, although probably not in the near future.

Gentlemen, I have been in your country for some five or six months. In no other country in the world could I possibly have received such a cordial welcome, or so much general hospitality and such unvarying kindness as I have received here. My stay in your country will always be one of the happiest recollections of my life. This is due in general to the unlimited kindness which I have received from every member of our profession, and in particular, to the very fortunate fact for me that a great portion of my duty and my time has been spent in the office of Surgeon General Gorgas.

To General Gorgas and his staff, many members of whom have joined the service within the last few months, I owe an unending and unlimited debt of gratitude. This debt does not rest upon my shoulders alone. The whole of the medical service of my army shares it with me, and not only they, but the whole British Army and the whole British nation, owes a debt of gratitude to the medical profession of the United States, which will never be forgotten.

When I came across here some few months ago, we in Great Britain were in sore straits owing to our scarcity of medical men and nurses. We appealed to you in this country to help us. The response to that appeal was generous and prompt beyond any expression. Since that time, nearly 900 medical officers and nearly 500 nurses have gone across the water to help Great Britain on the Western Front. The work which has been done and which is being done and which will be done by them is magnificent. Not a mail passes in which I do not receive letters from many of my brother officers from the highest ranks in both France and England, praising and expressing in terms of the highest eulogy and the most sincere gratitude the inestimable service which has been rendered by these officers and nurses.

Personally I very fully realize the amount of suffering, pain, and misery which has been alleviated by your brother medical men. I fully realize it, and we all fully realize it, and we are all grateful to you and thank you most heartily for it.

The friendship which has been felt for many years by the medical department of the armies and navies of the two nations will, I am confident, in the very near future be equally felt by the peoples of those two nations. Surely a year or less of adversity, of devotion to a common cause, the cause of humanity, of self-sacrifice and suffering will weld this friendship to an extent which never could have been obtained by centuries of prosperity.

Gentlemen, I wish I could express to you the gratitude which all my brother officers in the Royal Army Medical Corps feel to the medical profession of the United States. I am no orator, and I can only tell you that I thank you from my heart.

FRANCE AND THE GREAT WAR

By Colonel C. DERCLE
Representative of the Medical Department, French Army

I DEEPLY appreciate the warm reception which I have received this evening. The manifestations of your sympathy move me more since I know they are meant less for me than for France herself; France, whose boundless courage and indomitable valor you are applauding every day. In her name I thank you from the bottom of my heart. It is needless to say what France has done. Unprepared, she staggered from the blow of Germany which had prepared forty years for war, but after her surprise France gathered all her forces and energy and then, stronger than ever before, she intimated to the Kaiser's troops, so proud and sure of living in Paris, France intimated to them to stop and they stopped. Let us remember always the battle of the Marne where the glory of the French Army under the command of its chief, Maréchal Joffre, accomplished such wonderful things. I cannot describe the great devotion which we witnessed. Everyone hears the voice of duty and thinks of nothing else. Many have shown on the battle field, their devotion by giving their lives, and I wish to salute them with emotion and pay them a warm tribute. But their deaths have never caused the discouragement to those who were to follow. On the contrary, there have always been many to occupy the vacant places.

The American people has now come to help out as did the British people. We have now the British fury as we shall have in a short time the American fury. Your American Army will be served by a medical personnel of choice which will have at its disposal a man above all. I highly approve of everything I have seen in the training camps I have visited and I can see that everyone, physician and surgeon, will be absolutely prepared to do his war work when the hour strikes. That is naturally due to the personal enthusiasm and activity of Surgeon General Gorgas, who encourages everyone who works in his service. I wish him great success.

ENGLAND AND THE GREAT WAR

By Sir BERKELEY MOYNIHAN, C.B., Leeds, England[1]
Colonel, British Army Medical Service

ALMOST ample apology has been made already for me by Mr. Secretary Daniels, for he says that there can be hardly any more crippling embarrassment than that which comes from a certain amount of knowledge.

At midnight on August 4, 1914, England, to her lasting honor, declared war against Germany. At 8 a.m. on August 5, 1914, I became a soldier of my Sovereign. From that time until I stepped on board the boat at Liverpool, I have practiced military surgery, I have thought of military problems, and I have lived with military people. You will, therefore, expect from me some brief statement of the conditions under which we have worked, something of the failures we have made and something of the successes we have achieved in the work of the Royal Army Medical Corps of Great Britain.

There are about 30,000 medical men in the United Kingdom of Great Britain and Ireland, and of that number about 10,000 have been and are now wearing the King's uniform as officers in his Army. One-third, that is to say, speaking in round numbers, of the medical men in our Kingdom have entered the military service and have seen active service or have seen foreign service.

The Government has the right, and would, no doubt, be prepared to exercise the power, of taking every medical man of military age and compelling him to serve, but compulsion, with us has been and always will be quite unnecessary.

If, when the country is in danger, the medical profession does not respond to the call who, may I ask, is likely to do so? The medical profession in every country is probably that which has undergone a more complete education and has had better and closer opportunities for broadening the mind of each individual practitioner by contact with the most serious problems of life than any other profession. If, therefore, the intellectual aristocracy of a land does not rally to the flag, you cannot expect anybody else to do so.

We are as a profession, by intellectual descent, and by solemn adoption, the heirs of the men who have made our race great and famous.

May I tell you in brief what has happened with regard to the work of the Royal Army Medical Corps in my own center of Leeds. We have there, as some of you know, a civilian hospital of about 480 or 500 beds, with a staff of 4 surgeons and 4 assistant surgeons. When, with the far-sighted vigilance of Sir Alfred Keogh, a territorial system of hospitals was established throughout the country, Leeds was selected as one of the centers, and we were asked if we could provide accommodation for, and supply with an adequate medical and surgical staff, a military hospital of 520 beds. We agreed to do so and the men attached to the hospital staff became by that act officers in the territorial branch of the army. Of the 8 surgeons serving on the staff of the hospital, there are now 4 left at home, and in the 4 I include myself, who am sometimes in France, often in London, and occasionally in Leeds. With that depleted remaining staff, with the help of the practitioners in the neighborhood, we have now started and are running with an efficiency that I should not be ashamed to display to the most critical gaze of American surgeons, a group of military hospitals of 6,300 beds.

The record of the Royal Army Medical Corps may be looked upon from two points of view; we are both soldiers and doctors. As soldiers we go into any part of the line, from the trenches to the base, according to the needs of the moment.

Major Crile yesterday paid an eloquent tribute, which touched me very deeply, to those boys of ours, who, as regimental medical officers, are responsible for the health of the battalions which are actually in the fighting line.

Since the war began, until the 25th of August, which was the last date of which I could get information when I left England, we had suffered, roughly, in the Royal Army Medical Corps 1500 casualties; that is to say that number of men had been either killed or wounded or gassed or disabled from further service in the Army.

As you may know, the highest distinction which any Englishman can gain, in the opinion of every Englishman, is the Victoria Cross. We have gained more than our share of that most coveted distinction. Twice in the history of that order, a clasp has been gained, which means that the officer wearing the distinction has won his decoration twice. Both the men who have won that decoration twice are members of the Royal Army Medical Corps.

Though we are soldiers, we continue to be medical men, and I should like to tell you very briefly some of the achievements of the Corps, regarded from a scientific point of view.

The history of medicine in the tropics is the history of the military medical services of America and of Great Britain. The hands of all men build the Temple of Science but, now and again, once, perhaps twice, in a generation we have the high privilege of having among our number one of the great architects of the Temple of Science. You are perhaps just as full of joy as I am, to think at this moment and on this platform are two of the men, both of them Americans, who have designed some of the magnificent additions which are being made to that glorious Temple of Science, in Medicine and in Surgery. I need not tell you that I refer to General Gorgas and to Major Mayo.

[1]An Abstract.

To illustrate, among the things which the Royal Army Medical Corps have done in preventive medicine, one may quote, because it is easiest to convey the matter to a large audience, figures referring to typhoid fever: Ninety-eight per cent of the soldiers going over to fight in Flanders and in France in the British Army have been voluntarily inoculated against typhoid fever; and this is the result. In the South African War, which lasted, as you know, close on to three years, we had 57,684 cases of typhoid fever, with 8,022 deaths. In this war, with an army ten times as large, on a soil much more likely to bear carriers of typhoid and breed the flies by which typhoid in part is carried, we have had in all, up to the 25th of August of this year, 6,022 cases of typhoid fever, with 292 deaths. That is to say, we have had a far less number of cases of typhoid fever in this enormously larger Army living under infinitely more difficult circumstances, than we had of deaths in the South African War.

In many other directions we have as a corps helped to stamp out or reduce the virulence of the many other diseases.

As you know, in Africa one of the greatest pestilences which rages from the north to the south is known as bilharziosis. One-third of the population of northeastern Africa suffers from this disease. When once established it is absolutely incurable. The British Army is still paying pensions of something like seven thousand pounds a year to the men who contracted bilharziosis in the South African War.

At the beginning of this war, when it was realized that we would need to have an army in Egypt, a detachment of medical men was sent out in order to study this disease, with the result that the alternative host of the parasite has been recognized in all his varieties, his modes of life have been probed to the bottom, all his domestic secrets are revealed, and rapidly he is being exterminated. In all human probability, bilharziosis which has existed from the days of the Pharaohs down to the beginning of the war, will be stamped out from the face of the earth.

In many other directions, which I will not trouble now to cite to you, we have made very pronounced progress in respect to our investigation of spirochætosis, trench fever, dysentery, malaria, cerebrospinal fever and many other parasitic diseases. I leave out of account for the moment any description of the surgical advancement, because that will be discussed later, on other evenings in the week.

The profession, immediately on the outbreak of war, rallied to the standard which was set up, with the utmost expedition. We have been in England, as you are and always have been in America, a peace loving nation, practicing the arts and enjoying the fruits of peace. But we had no choice as to what we should do when Germany violated the sanctity of Belgian territory, for if England stands for anything she stands for the sanctity of those treaty obligations which Germany violated, and which regarded only as scraps of paper, to be torn up when she so desires. She stands for justice and its administration. She stands for the rights of small nations; and by reason of these ideals we have kept our Empire together, by cords which were invisible but which have borne, as you know, the strain of this war in a manner which nobody three and a half years ago would have credited as being possible.

We entered the war with our "contemptible" little army, and though we have buried our dead in thousands, and though we have taken back to England our wounded in hundreds of thousands — I could even say a larger figure — the Nation has not regretted for one single instant the action that we took in August, 1914. We have never doubted that it was our duty to go on; we have never questioned the infamy that would have attached to us forever if for one instant we had swerved aside.

Germany, as you know, planned this war with all the care that Germany can bestow upon matters of this kind. She timed the war, we realized now, with absolute certainty, for the beginning of August, 1914. The miracle, the unexplained miracle, the inexplicable miracle, is that she has not won the war, and did not win it outright.

After the second battle of Ypres, we were given a time for rest and recuperation. We were given time to make preparations to fight them and we were also given time to realize, as we had never realized before, what the German menace really meant. We had to learn something of the bestial indifference of Germany to anything that can be called the rights of man.

We had to learn with stupefaction and dismay of the craft and the cruelty that seem innate in the German nature. We had to learn, as we did learn in February, 1915, of the hideous malignity of the submarine peril and the submarine morality of the German nation; and horror was piled on horror during those months of waiting. There were arson, and plunder, and rapine, and lust, and every form of hate. Germany launched against us her whole apparatus of infamy; and finally there came the tragedy of Miss Cavell. Now, an Englishman thinks and you think too, of course, that it is a most infamous outrage to lay a hand on any woman, but it is sacrilege to lay hands upon a nurse.

And so the weary months and years of the war went on for us until at last the challenge was thrown to America, and you in America learned of the contempt that Germany had for you. You are now realizing, as we have, for a long time, the hate that she has for you. But it is a great compliment, the German hate, for her hate is the other side of fear.

And America came into the war. But as you know America had been in the war for a long time before that. In the early months of 1915, I went to Paris and I found my old friend Crile hard at work. In March of this year, before you were in, when most of the world, in Germany, thought you were never likely to come in, the French Government did

me the honor of sending me to Verdun; and I went through the whole of Verdun, the most glorious and sacred soil in Europe.

I walked through Verdun and found it a city of the dead. Verdun was destroyed; but the houses were standing, the ends of some of them blown off, the roofs of some of them blown off; and others burned down. But most of the houses or parts of them at least seemed to be there, and one did not realize until one had walked through the streets for a few minutes, that it was a city that was dead. There was nobody in it at all. The echo of a footstep made a blue coated *poilu* put his head out of a cellar just to see who was coming. I walked about Verdun, and beyond the town, up toward the firing line, and at the most advanced point I reached, I went down into a cellar, to a dug-out excavation, and there I found an American ambulance, which for over twelve months had been incessantly under fire, such fire as up until the last few months the world had never believed it possible to witness. I found a band of young, happy, cheery Americans, doing their best for what they told me was just as much their fight as mine.

And now that you are fighting Germany, the first thing that I would beg you always to carry in your hearts, never for one instant to let it go from your recollection, is that Germany is a great and a powerful nation. She has an implacable hatred both of you and of us. In fact, I do not know to whom she now casts her highest favor; but you may be sure in this war, with her reserves which come up fresh at the rate of a million and a quarter every year, she will use against you and against us every dirty device that she can think of, and everything which the tortured ingenuity of her mind can contrive against you.

A question that I have often been asked since I came over to America is, "When is the war going to end?" I believe America will find, as we have found, that for her the war will begin when every man of military age in the whole country has offered his services and is prepared to surrender his life for his country; when upon the high altar of your patriotism you have reverently laid your wealth, your lives, your honor and your souls; when some day you welcome home the bodies of your most honored dead, and when you see moving about your streets as we do at home, those relics of humanity, who have offered their lives and given their limbs or their health, that your homes might be safe.

My great hope from this war, now that America and England stand at last side by side, is that many of the stupid, petty, and miserable little differences between us which were never really of serious consequence, shall disappear, and that as you and we walk together through the furnace of affliction, we shall be welded together for a united purpose; the upraising of a spirit of freedom and liberty in all other peoples, and that we shall be sponsors together at the new birth of freedom.

The quotation oftenest made I am sure by Americans since this war began is the famous remark made by General Sherman. I have seen something of it and I can tell you of my own knowledge that "War *is* hell." But there is a hell of suffering and a hell of shame. We have walked through the hell of suffering. We have been scorched by it, and our hearts have been seared by it; but we realize that, after all, the effect of it is purification.

But there is also a hell of dishonor that would have burned in the soul of every man of us if in this great testing time of our race we had turned aside and had been false to the glorious traditions which we have inherited.

Some day — it is not a near day — but some day the sun of righteousness and justice and truth and freedom will appear and throw its blazing, full heat upon all the peoples of the earth. That sun has not yet risen. It is still almost night, or. it maybe that, we are now only in the cold clammy hours that herald the morn; and already, as we look out toward the east and across the ocean, through a heavy grey mists, there is a promise of the dawn.

THE WORK OF THE AMERICAN UNITS IN FRANCE

By Major GEORGE W. CRILE, M.R.C., U.S.A.

DURING my service in France, I heard no one express the opinion that the enemy was wavering or that he was starving; that he was short of munitions or that he no longer fights a hard fight; or that the Imperial Power is crumbling.

I have seen and talked with many German prisoners. They were strong, robust, and mature. They were well clothed and well shod. On the other hand, I have heard from hundreds of British soldiers that when the Briton and the Teuton meet — man to man — that the Teuton surrenders — this merely shows good judgment!

I know the British and the French now have the superiority in guns and in munitions. *The British and the French are Top Dogs Now!*

As to the duration of the war, everyone in France takes it for granted that the war will be long, that it is perhaps *half* over. The opinion that the enemy is weakening, that he is nearing a collapse, that he is on the brink of revolution, in short, that the war is almost over I have heard only since I landed in New York. This shows how successful is the peace offensive that Germany is waging against the United States.

We hear the high appeal of the President, the

appeal of the Council of National Defense, and the appeal of patriotic citizens to us to subscribe to the Liberty Loan; to conserve food; to relinquish luxuries; to put on the uniform; but while these energizing appeals enter one ear, the enervating word of Peace is whispered into the other by our enemy. To speak of peace now seems as inconsistent as it would be for the Allies to throw an antidote after each gas shell. Germany has all but convinced us that hers has been the Empire of Peace; that she invented peace, and that she will soon open universities to teach peace and good will to a wicked world.

One day Amsterdam tells us the German navy is in mutiny — the next day it delivers a terrible blow upon an Ally. One day Switzerland tells us that the people of Germany are rising in their might to overthrow militarism and the next day they subscribe a three billion loan for the continuance of militarism. Any day we may hear from Amsterdam that the ruthless submarining was not done by the peace-loving German navy but by the Swiss navy.

For the last six months it has been my great privilege to be in the service of the allies for the Lakeside Unit, to which I belong, and which was assigned to service with the British Expeditionary Forces. My comments, therefore, must refer largely to my experience within the British lines, though from what I have seen of the French I believe that had I been assigned to them my experience would have been no less illuminating, no less advantageous.

From our cordial and helpful reception here by the accredited representative of the British Army, Colonel Goodwin; to the reception of the Lakeside Unit upon its arrival in London, and its reception upon its arrival within the British lines in France, every point of contact with the British, officially as a unit, and unofficially as individuals, on the part of medical officers, nurses and privates, was so sincerely cordial, so constructively helpful, that we were speedily given possession of the knowledge gained by a great profession in *three years' intensive* military experience.

It is to the credit of our Surgeon General that his department was so well organized and his hospitals so mobile that the medical department of our army was the first to enter the active field of war.

The plan of organization of the base hospitals of America by General Gorgas and by Colonel Kean has proved most satisfactory under the test of actual field service. The following six base hospital units are serving under the British Expeditionary Forces: the Northwestern University Unit, of Chicago, under Dr. Besley; the Presbyterian Hospital Unit, of New York, under Dr. Brewer; the Harvard Unit, of Boston, under Dr. Cushing; the University of Pennsylvania Unit, of Philadelphia, under Dr. Harte; the Washington University Unit, of St. Louis, under Dr. Murphy; the Lakeside Hospital Unit, of Cleveland, under Dr. Crile.

These six American Base Hospitals have taken over British hospitals ranging from 1600 to 2000 beds each. During their six months' service the personnel has been engaged in research and in studying methods and organization. They are learning from masters of surgery and of medicine, from masters of sanitation and of research.

These base hospitals have also thrown many surgical teams forward into the front area for service in the casualty clearing stations. Here these surgical teams operate — eat, sleep and dodge bombs; then operate, eat, sleep and dodge again.

In addition to these units, there are several hundred younger men in the front area, serving in the field ambulances and attached to divisions of the British army. These men are always under fire. They frequently shake hands with fate. I need not tell you that they stand by their posts and perform their tasks bravely. We know them too well to doubt that. When they return we shall find them matured — we shall find them sobered and seasoned. They will be men of whom we all shall be proud.

WHAT HAS THE BRITISH MEDICAL SERVICE ACCOMPLISHED?

They have kept their vast army, that vast army that lives like amphibians in the chill water and mud of Flanders, more free from colds, from pneumonia, from typhoid, than your civilian population of Chicago. They have made a medical organization so perfect that their transport has never failed in a single instance, under the exigencies of many battles. Through perfection of organization, through research and surgical experience, through the invention of new instruments and apparatus, of new methods and new technique, *the death rate from wounds, operations and infections in the British and French lines is reduced to an incredible minimum.*

Limbs and functions have been restored and a large proportion of all the wounded has been promptly returned to the firing line. Thus a vast army of soldiers has been returned to active service, soldiers *who wear the insignia of having been wounded*, a badge of honor indeed to British and French surgery.

But the long pull of war service, with its single train of thought, its single set of problems, with its barbed-wire limitations of privilege, made by military necessity,— this long endurance of friendly imprisonment has made its impression upon this band of workers — a band remarkable for intelligence, patriotism, devotion, strength of body and of mind — a picked group of differentiated young surgeons who must some day become war-weary. Unless relieved in time their initiative will be handicapped and they will be forced to wonder what is to become of them after the war!

RUPERT BLUE, M.D., D.SC.
Surgeon General, United States Public Health Service

I went to France as a novice in military surgery. Let me give you a few impressions. My duties took me, at various times during the summer, through beautiful Normandy into shell-riddled Flanders. I first saw the blossoms growing; I saw grain and maturing fruit; I saw the harvest; I saw many villages and towns and cities. Everywhere I saw meager power — meager horsepower — meager gasoline power — meager coal and wood power. Of human power I saw only the feeble power of childhood and the waning power of advancing age. I saw the aged men and women stumbling at their tasks in the fields. I saw the soft hand of childhood gripping the hard wheels of toil. The strong men were at war or were dead. The strong women were in the munitions factories. When the children closed their weary day of toil they took their frugal meals and secured their rest and sleep in chill, cheerless houses within sound of the enemy's guns. And why do they thus toil? *For power!* Power to keep their *war machine alive!*

When I disembarked in New York a few nights ago, from a darkened ship, it seemed as if the city must be afire, so stupendously excessive was the glow of light. In my taxicab I read by the light of the advertising signs the newspaper appeal to the American nation to conserve its coal and light for her Allies. It seemed as if as much light was being wasted in advertisement alone as is used in all of France for maintaining life. If we have heat, light, and power to thus throw away — why not throw it across the sea to lessen the chill and darkness of France.

WHAT IS A WAR MACHINE?

A war machine is a vast mechanism — a mechanism miles in depth and miles in length — a mechanism which includes within it iron and steel and copper and lead and aluminum; oil, petrol, glycerine and the nitrates; it includes the hides of animals and the fleeces of sheep; the timber of the forests and the destructive elements of the earth and of the air; it includes grain and fruit and flesh; it includes cotton and hemp; it includes all that sustains man; all that clothes man; all that maintains the health of man and all that gives him power to maim, to exhaust and to kill; it includes the produce of every field, of every forest and of every mine; it includes things created through the labors of millions of men and of women and of children. When the materials of this war machine are assembled it occupies the highways, the fields, the earth below and the sky above. One part of the machine blasts and breaks and tears, terrorizes and kills; the other part conserves and discovers, assuages and relieves, reclaims and rebuilds. This is the medical part, our part of this war machine!

At the present moment the demands upon surgery are unsurpassed. Men are inflicting upon each other every conceivable injury. The world has become one vast hospital. A new set of surgical problems has arisen. These new problems should be solved. We must abandon our more personal interests — we must think and act in terms of a wounded race. Many surgeons will be called to leave their civil practice and devote themselves to doing for the wounded man what has been done for the man with tumors and ulcers and deformities — what has been done for the gall-bladder, the appendix, the stomach, the intestines, the thyroid. The same intense devotion, by the same class of surgeons, toward the problems of the wounded soldier, would do for these fellow citizens, to whose sacrifice our national destiny is committed, what has been done for the civilians who remain at home. It is a serious mistake to suppose that military surgery is the surgery for the unskilled. Civil practice demands perhaps finer dissections but military surgery demands a deeper knowledge of principles, a greater versatility. It demands the ability to stand by on twelve-hour shifts and to meet every variety of surgical problem of the head, the neck, the abdomen; of joints, of the extremities; of the chest; as well as hæmorrhage, shock, exhaustion, and gas gangrene in kaleidoscopic sequence. What surgeon is too able to do these? Can any man perform these operations, meet these problems better than the wounded soldier deserves?

The highlights of war surgery are romantic, for in a brief season whole areas of the body are conquered; great principles are worked out; foundation stones are laid. During battles patients come in volleys. The surgeon is barraged with fractures; he is shelled with broken heads; bombed with bellies; gassed with wounds. If he is interested in any subject and says so, the stream is turned on him day and night until he surrenders. If he wants postmortem material, he chooses from the daily pile. If he desires transfusions he keeps a stream of blood flowing from donor to recipient day and night. More progress has been made in the surgery of the chest and abdomen, in the treatment of wounds, of infections, of hæmorrhage and exhaustion; more knowledge has been accumulated of splints; of apparatus; and of every applicable mechanism in the brief three years of war than in the past generation. Every day witnesses a new evolution. The best talent of the world is concentrating on the battle line. Do you want to render a service equal to that of putting 100,000 well-trained soldiers in the field? Then discover a method of abolishing lice and itch from the armies; discover how to prevent trench fever and trench nephritis — and one-half of the invalidism of the army will be abolished. The cost of killing men has constantly risen, until now it probably costs more than $100,000 to kill a man. When, through medical discovery, thousands of men can be saved — what more romantic service can there be than to play the great game of preventive medicine for such a stupendous stake?

The present war is a contest of ideas rather than of men. In its broadest sense, war is the practical application of physics, chemistry, and biology in a mass struggle for the existence of nations. The battle itself is the applied science of killing. The group that will survive will be the group that will furnish the most effective ideas and men. Today so terrible is the menace of the correlated sciences of our able enemy that our first line trenches must also include our scientific laboratories. Only by throwing into the arena our intellectual as well as our material forces, will we achieve survival.

THE SURGEONS OF THE ARMY

By Surgeon General WILLIAM C. GORGAS, U.S.A.

I WOULD like merely tonight to introduce the general subject of the work of the military surgeon, and leave the elaboration of the subject to the gentlemen who will follow me.

In our situation at present the subject is a most interesting and important one, and of course, to the Medical Corps of the Army, of paramount importance. My personal experience in military surgery is nil. I am one of those unfortunate soldiers who has been in the Army for forty years, but has had the misfortune to hear only those hostile bullets that were fired in our little Spanish-American War.

Since that time military surgery has practically been born over again. This great war has demonstrated the fact that we will have to add enormously to those procedures that were recognized and adopted before this great struggle came on.

It would hardly be appropriate, having had no personal experience in the present war, for me to call attention to the matter, but I have heard it so much discussed and read so many reports on the subject and been so much interested, that I think I might venture to say that the whole question turns upon the problem of sepsis, the endeavor of the military surgeon to get at the wound as quickly as possible in the effort to keep it free from infection, or if it is already infected to restore it to normal in the shortest possible time. The principal rule of the Army administrator will be to arrange affairs so that the surgeons in immediate charge of the wounded can set about to accomplish these things, at the earliest possible moment.

With this object in view, we should have all our hospitals, all our arrangements for caring for the wounded, made as close to the front line as possible. All our plans and energies will be bent toward this central object.

THE SURGEONS OF THE NAVY

By Surgeon General WILLIAM C. BRAISTED, U.S.N.

I HAVE been requested to talk to you for the next few minutes on "Surgeons of the Navy." I feel justified, however, in taking this opportunity to talk to you on the more general subject of the Medical Department of the Navy and to endeavor to present to you briefly our status as it was before the outbreak of hostilities, the expansion which has been found necessary and the present condition, both as regards personnel and material.

On April 6 there were 64,680 enlisted men in the regular Navy; now there are 143,726; an increase of 79,046. The Naval Reserve Force has increased from about 10,000 to 49,000; 14,500 Naval Militia are in the Federal service; the Coast Guard with its force of 5000 has been transferred to the Navy for the duration of the War; the Hospital Corps has been increased from 2,000 to 6,500; the Marine Corps has increased from 13,266 enlisted men on April 6 to an enlisted strength, with reserves, of about 32,348; there are about 12,000 officers in the Navy and 1,122 in the Marine Corps. The Navy and Marine Corps now constitute a force of more than a quarter of a million men.

The Medical Corps of the Navy on April 6 contained 304 commissioned officers; today it has 828 officers, either commissioned or awaiting commission, this being the full authorized strength of the Medical Corps as allowed by law. The comparatively limited age requirements for the Medical Corps, i.e., 21 to 32 years of age, have necessarily prevented the acceptance of thousands of patriotic offers of service by medical men throughout the country, for duty with that corps. I am very glad to say, however, that those candidates who have been secured to fill these permanent positions are of an unusually high type of training and general excellence, redound to the credit of our medical schools, and I hope and believe will continue to be a credit to the Medical Corps of the Navy.

In order to meet the urgent need for men and to assure the quality of the material, a campaign was instituted early in this year among the class "A" medical schools of the country, and the advantages and opportunities of a naval career were presented to the prospective graduates of the senior classes. Only candidates who were certified by their deans

as being of exceptionally high standing in their school careers were offered the opportunity of qualifying for naval service. Some 329 officers were obtained for the Naval Reserve Force in this way and of these about 70 per cent have been found qualified and commissioned in the Medical Corps of the Navy. While these young men have necessarily lost some of the benefits to be derived from postgraduate interneships in the civilian hospitals, it has been my effort and will continue to be so to provide them such duty as will furnish them opportunities in their naval service equal to those that they have relinquished.

As this increase has presented itself as practically one increment it was found impossible to put those young officers who were prospective candidates for the permanent service, i.e., Medical Corps, through the Naval Medical School in one class; we, therefore, with the enthusiastic assistance of the teaching staffs of the medical colleges of our larger centers instituted courses of instruction for these officers in Boston, New York, Philadelphia, Chicago and San Francisco, as well as at the Naval Medical School, Washington, D. C. We have been thus at a very rapid rate converting this material of excellent professional training, but unused to Navy routine, into medical officers of initiative and self-reliance who will be well qualified for the routine of independent duty when the necessity arises. Abundant bedside work is provided by our naval hospitals as well as by the civilian hospitals connected with these teaching institutions.

I am very glad to say that the offers of services from the medical men of the country for duty in the present emergency have been far more numerous than the Navy could utilize. Owing to this fact, an effort has been made to restrict the acceptance of such offers of service for the Naval Reserve Force to the relatively younger men with considerable recent hospital experience. In addition to 828 members of the Medical Corps of the Navy, we have now available for active detail over 700 members of the Naval Reserve Force; 74 Medical Reserve Corps officers; 24 acting assistant surgeons; 96 retired officers; 77 National Naval Volunteers and Naval Militia officers, and 21 medical officers of the Coast Guard — a total of approximately 1800 medical officers.

Owing to the possibility of limiting our acceptance of services to young internes, there has been no question of the appropriateness of enrolling all in the grade of assistant surgeon. No advanced ranks on appointment from civil life have been issued except in connection with Red Cross duty, and thus much of the embitterment which might have been encountered has been obviated.

I believe that in these comparatively youthful, energetic, and ambitious younger men, fresh from the abundance of bedside, operative, and laboratory work, which is available in our great modern hospitals, the Navy has secured the finest and most appropriate material for the varied problems to be encountered in naval life. In the numerous small or large scattered units that constitute our floating force, our medical officers must necessarily themselves handle all cases encountered and unless in the vicinity of a naval hospital cannot do what their colleagues in civil life would do, refer a troublesome case to a specialist.

As I have referred to the American Red Cross, I will state here briefly that the Navy has at present 12 hospital units organized under, and in conjunction with, the American Red Cross — 5 large Navy Base Hospitals and 7 smaller Naval Station Hospitals, the majority of which are now on active duty and rendering helpful and efficient service.

The Hospital Corps of the Navy, our nursing force, which numbered less than 2,000 before the outbreak of the war, now has in active and reserve force of some 6,500. Four Hospital Corps schools are maintained by the Navy and these have been working at high pressure to handle this new material obtained. Special methods of instruction for the hospital corpsmen serving with military forces have been undertaken with a very satisfactory degree of success in view of the short time that has elapsed. Improvement in this type of training is looked for now that experience already gained in France is being utilized in this training. During the coming months the course of instruction at the Hospital Corps schools will be gradually increased again until it reaches the normal period of six months. The medical service for the care of our men ashore and afloat has been rapidly and satisfactorily expanded and has more than kept pace with the increased personnel in a way which has been gratifying. From the smallest detached unit to the largest naval center the appropriate facilities and accommodations have been provided for the care of the sick and wounded and for the prevention of disease. Extensive emergency hospital construction has been provided where the existing naval or civilian accommodations did not seem to meet the current or prospective conditions.

The Public Health Service has been most courteous in its co-operation with the Navy, and sanitary inspection has been made at all Naval Stations by officers of that service who have been transferred to the Navy for duty and assigned one to each Naval District. Sanitary surveys have also been made of the zones surrounding Naval Stations and of the towns or cities in which section bases, training camps, aviation schools, etc., are situated. Efforts are being made to meet winter conditions by putting in force the required sanitary measures before the advent of cold weather.

Three hospital ships are now under construction for the Navy, one commenced last year, being new construction, the other two being converted from passenger-carrying vessels. None of these, however, is as yet available and it will be some months before that can be the case. Our older hospital ship, the U. S. S. Solace, has been of tremendous benefit during its entire service in the Navy and

particularly so at the present time, with the crowded condition of the fleet. The ambulance ship Surf which was so generously provided by Dr. John A. Harris of New York City, proved of great service in relieving the stress imposed upon the Solace, in evacuating the sick from the fleet to the nearest hospital base.

In closing these few remarks I want to express to the medical men of the country my sincere appreciation of the high spirit of patriotism that has been demonstrated by our profession. No class of men has been more prompt in its response to its country's needs and no class has in doing so been so self-scrificing as the medical men of our great country. And through the sacrifices, inconveniences and hardships, not only of themselves, but of those whom they have left behind, they have upheld the dignity and prestige of their great calling and have emphasized once again their adherence to the tenets of their Hippocratic oath.

THE TRAINING OF MEDICAL RESERVE OFFICERS

By Colonel EDWARD L. MUNSON, M.C., U.S.A.

THE outbreak of war found the United States possessing approximately only 500 officers well qualified to conduct the work of the Medical Department. This number included all regulars of more than one year's service and the best of the National Guard and Medical Reserve Corps.

Existing law officially recognized the need for seven medical officers per thousand strength, and the British experience was that ten per thousand were needed for all purpses.

As Congress had provided for the recruiting of a total force of 1,850,000 men, it was clear that some 18,500 doctors would be needed for such force. On this basis, one could regard 2.8 per cent of our necessary medical personnel as trained, and 97.2 per cent as untrained in whole or part.

Some idea of the task confronting the Medical Department may be gained from the facts that for the medical service alone, of the military forces authorized by Congress, the medical personnel, officers and men, would approximate a quarter of a million, or about twice the total strength of the entire army of the United States the day war was declared; that commissioned medical officers and dental surgeons alone would approximate in number the entire strength of our regular army at the outbreak of the war with Spain; that hospitals would have to be provided and administered in capacity sufficient to give a hospital bed to every man, woman, and child in a community like Kansas City; that the ambulance companies and field hospitals marching with fighting troops would occupy a road space as long as from Washington to Philadelphia, and that the present annual appropriations for medical facilities and supplies would exceed that for the entire Army a year ago.

It seemed evident that the Medical Department would be quite unable to carry the burden about to be imposed upon it, unless this vast mass of willing, able, but raw, professional material was promptly taken in hand and its members systematically and intensively trained in military methods, purposes and environment, and the effect which these would have upon professional practice. It was clear that, in order to reduce the results of lost motion, friction and ignorance, the medical personnel would have to be organized, merge its individuality in a vast machine and be familiarized with the operation of the latter.

For this purpose, the Surgeon General asked and received authority for the establishment of four great medical training camps, much on the order of the citizens' training camps in organization and administration. One of these camps is at Fort Benjamin Harrison, near Indianapolis; another at Fort Riley, Kansas; another at Fort Oglethorpe, Georgia; and a fourth at Leon Springs, near San Antonio, Texas. The last named, however, was never organized, due to inability to provide instructors as a result of pressing need for medical officers elsewhere.

The above three camps each have accommodations for approximately 1200 medical officers, and some 3,000 enlisted men of the Medical Department.

In addition, a camp for colored medical officers and men was established at Fort Des Moines, Iowa, with about 150 colored medical officers and 1000 colored enlisted men in attendance.

A camp for the U. S. Army Ambulance Corps, a special organization for service with the French Army, was started at Allentown, Pa., with a capacity of 150 medical officers and 4500 enlisted men.

Finally, at Fort Ethan Allen, Vermont, a camp, primarily for the training of enlisted men, was developed, with about 50 medical officers and 2000 enlisted men of the Medical Department.

At the present writing, then, the Medical Department has some 3900 doctors under instruction at medical training camps, with some 16,500 enlisted men, or a total of some 20,000. To this must be added the larger number of medical officers and men already on duty in divisional camps and cantonment hospitals and receiving systematized instruction in addition to performing daily duties.

In a general way, the medical men sent to these camps are, for physical reasons, under forty-five

years of age. As they are to serve in the field with fighting troops and handle large bodies of men and wounded, they must have physical stamina, force of character, quick judgment, sound decision and ability to command confidence of officers and enlisted men alike. These qualities the camps inculcate.

Older men, professional experts of long experience, and leaders of the profession, find their greatest usefulness in purely professional duties in fixed hospitals and other formations in the rear. They are not ordinarily sent to training camps, except at their own request.

The new arrivals at the medical training camps are good doctors, but wholly ignorant of the additional qualifications required of medical officers. How raw the medical recruit is may be inferred from the fact that, duly instigated, they cheerfully go on errands of the adjutant for the "keys to the store tent," or to the Quartermaster for "thirty yards of skirmish line." One entire company of medical officer "rookies" missed a review because some wag entered their barracks and announced in stentorian tones that it looked like rain and that the company should send forthwith to the Quartermaster for an issue of olive drab umbrellas — which the guileless company proceeded to do.

There seems to have been in some quarters some doubt as to the nature and purpose of these medical training camps. They are not professional schools. The doctors accepted for service have already been examined and found competent as practitioners of medicine and surgery. What the camps do is to fit such practitioner for military service, and particularly for service in the front line with fighting troops. It usually takes the new recruit about a fortnight to understand this purpose and its necessity. Training is physical, military, disciplinary, and professional.

Bearing in mind that these camps are training officers especially for service with fighting troops, much stress is laid upon the development of high physical efficiency. For in the absence of high physical powers and ability to support fatigue and privation, it is clear that mere professional excellence would have little value.

The medical officer must be able to march as far, and live under the same conditions, as the line troops with whom he serves. During the fight, he shares all its dangers and hardships. After the fight is over, and the line troops can have a rest, is the time when the medical officer faces his heaviest task. There is no place for the medical weakling at the front. He must do all that the line troops do, and then his special professional work in addition.

For this reason, the curriculum starts in each day with fifteen minutes "setting up exercise," and includes three hours of drill, marching or equitation. The physical improvement manifested in the average doctor in a few weeks as a result of this training is remarkable. He arrives soft, flabby, often somewhat paunchy, of bad posture, a creature of the automobile era, unable to ride or march. He leaves erect, firm and muscled, well set up, and able to do in marching whatever the needs of the service may demand. His waist measure has decreased from two to seven inches, his chest has filled out, and in Navy parlance, he has "shifted his ballast." He feels better than ever in his life and additional years of vigor and usefulness have unquestionably been conferred on him.

This physical training is carried out under doctors experienced in physical training and is graded to the individual. For example, the physical training at one camp is conducted by medical officers formerly physical directors at Leland Stanford University, and of the Y. M. C. A. of St. Louis. It includes setting up exercises, marching and other drills, "hikes" and equitation. This physical training continues throughout the entire course of three months.

The military special training of the first month is basic. It includes much that the medical officer will never have to do himself — as transporting wounded, putting up tentage, handling of equipment, etc.— but which he will have to teach enlisted subordinates how to perform. Before the War, non-commissioned officers did most of this work. Most of these experienced men have been promoted and for practical purposes this class of "shock absorbers" no longer exists. The medical officers will make them later from present raw recruits. In the meantime, the medical officers must do their duty as instructors of enlisted men. They can only do it through learning it, and they can learn it best by actual performance of each task that they will have to instruct their subordinates to perform. For this reason, the camps are organized on a cadet basis, through which medical officers pass as privates, corporals and sergeants before becoming organization commanders. There is much competition for such promotion, and it is the rule that the successful men here are the successful men in civil life. Of a certain bunch of fourteen corporals made, it turned out that ten were professors in medical colleges.

The handling of men, the maintenance of discipline and order, the psychology of the soldier, the direction of large organizations and masses of sanitary groups, which is indispensable to team efficiency, is taught by actual practice. Doctors seem particularly quick to grasp both the importance and methods of such work.

Following instruction in the work of enlisted men, which lasts about one month, the doctor takes up his work as a medical officer. He learns how to handle efficiently regimental detachments, ambulance companies and field hospitals by actual detail with them. He administers them, camps and marches with them, and handles them in problems and maneuvers. This is live, active work, which appeals to many men, and is made as much like real conditions of war as circumstances permit. It is astonishing how many shining lights of the

profession become enthusiastic students of the psychology of medical pack mules or the mechanics of the insides of motor ambulances.

In the first and second month, the newly fledged officer learns Army regulations and the prescribed business methods of the Medical Department and other branches of the Army. He learns the relation that he and the Medical Department bear to the rest of the Army. He learns paper work by actually making out all papers and submitting them to a censor, whose blue pencil is ruthless.

In the second and third month, he takes up professional matters where these are modified by military environment.

As the average civilian practitioner has a limited knowledge of hygiene, much attention is given to this in the form of the hygiene of troops and practical applied camp sanitation. The care of troops is a subject of such basic importance and constant application that it cannot be overemphasized.

A course of reading, lectures, and some demonstrations are given in such elements of war surgery as differentiate it from ordinary accident surgery of civil life. Gas equipment has just become available and much attention will be given to gas protection and the treatment of gassed cases. Shell shock, the war neuroses and psychoses, "trench foot," diseases common among troops on the Western front, malingering, etc., complete the professional subjects which are covered. Postgraduate courses qualify selected officers as sanitary inspectors, as commanders, adjutants, and quartermasters of hospitals, as directors of ambulance companies and field hospitals, etc.

After finishing the basic instruction, selected enlisted men are qualified by special courses as non-commissioned officers, clerks, cooks, dispensary and surgical assistants, ward nurses, drivers, chauffeurs, gas engine men, etc.

These training camps are now turning out in excess of a thousand well qualified medical officers monthly, and several thousand enlisted men, a large part of whom are potential non-commissioned officers. In a single day, these training camps sent to each of fifteen camps of National Army divisions, a solid train load of medical officers and enlisted men, 400 in number, divided into hand picked detachments for each regiment, ambulance company and field hospital, so that they were going concerns before the line organizations with which they were to serve were on the ground.

After completing instruction at medical camps, officers and men are assigned to service with troops. This merely means a continuation of training. Any defects in medico-military education are remedied. But the special feature of this second course is the training in their respective special lines of work given the medical officer group of the division and adjoining base hospital by the selected specialists and experts attached to such hospital. In this course, the medical officer is brought back again to his profession and is taught the advantage of professional teamwork and the utilization of the specialist.

In a series of sessions, conferences, clinics and demonstrations, the X-ray expert, for example, shows how roentgenology can best be utilized by the general practitioner in the Army; the laboratory man how the laboratory tests contribute to precision of diagnosis; the orthopedic surgeon explains the functions of his specialty; the internist discusses the diseases specially common in the trenches, etc. All this not with a view of making a specialist of the average medical officer, but to demonstrate to him the advantages and methods of professional teamwork, as modified by the necessities of military service. This second course of advanced and professional training is already ordered to begin on November 1 in thirty-eight divisions and cantonment hospitals, where it will affect some 5,000 medical officers.

A third plan of training, which is had in mind, is later to give a course in purely professional clinical instruction, in the wards of great military hospitals, to those whose clinical education in civil life has not been as extensive as is desirable.

The training scheme as a whole thus not only plans to qualify doctors as medical officers, but to make them better doctors.

That the results of the foregoing training have borne out the anticipation is shown by the fact that division surgeons and others uniformly speak of the far greater efficiency in the service of the officers sent to them from medical officers' training camps, as compared with those direct from civil life. They have assumed their new duties with confidence and ability. The line officers most favorably comment upon it. Finally, the medical officers who have been graduated from the training camps themselves realize the great practical value of their instruction, and are writing back very many letters of appreciation and thanks to the staffs of instructors.

LABORATORIES IN THE ARMY

By Colonel F. F. RUSSELL, M.C., U.S.A.

THE subject of laboratories in the army is one which does not lend itself to much that is either new or novel; a description of an army laboratory would not differ materially from that in a civil institution.

At the present time, we are confronted with the process of expansion rather than with the introduction of new principles. None of the problems confronting us in this country is new in principle, although the association of very large numbers of young men of susceptible age will no doubt force us to find simpler and less cumbersome methods of control of infectious diseases than we now have. Our efforts will be to put into practice everywhere the principles which we now carry out effectively only in our larger cities. Since the days of General Sternberg, every military hospital has been provided with a suitable room and a standard outfit of apparatus for laboratory work. In 1893, after the World's Fair here in Chicago, the Army Medical Corps exhibit was sent to Washington, and with that apparatus as a nucleus, an Army Medical School was started under Major Walter Reed, who had James Carroll as his assistant. At its beginning, the school consisted merely of Walter Reed's laboratory. As time went on the present Army Medical School grew up around the laboratory, which has always remained the principal part of the course. Walter Reed and his successors have trained all the new men in the regular corps since 1893, with the exception of two years — the time of the Spanish war.

Our next step was taken about 1909 when the department laboratories were first organized to meet the call for more specialized technical service. It had been shown that it was not enough to fit up a laboratory in every post hospital, that there were many sorts of work requiring a high degree of technical skill, which could be done by special laboratory men, and that the general surgeon and the general practitioner had neither the time nor training to make the newer tests. Department laboratories have been established now from time to time, and they are now working in Manila, San Francisco, San Antonio, Atlanta, Fort Leavenworth, Washington, and Ancon, Canal Zone. Since last spring, these institutions have expanded greatly and all are now large institutions with staffs of six to twenty men or more. Up to the present time, they have been our principal reliance for technical work, and will continue to be until the new cantonment laboratories are working smoothly. In these laboratories, we have done Wassermann and other complement fixation reactions since 1909. Most tissue examinations, all the medico-legal work and many of the water examinations, blood cultures and typhoid carrier work have been made in such places. It is possible to summarize the scope of the work of the department laboratories by stating that they have done all and any sort of laboratory work which could be done with specimens sent through the mails.

The new work has been the establishment of new and adequate laboratories in the semi-permanent cantonments of the National Army and National Guard, and at the general hospitals which are gradually coming into being at the older army posts throughout the country.

The new cantonments have a population of from 20 to 40 thousand or more, with a camp hospital large enough to care for 3 per cent of the population. The laboratory, therefore, must be able to handle the public health work of a community of that size and also to do the clinical laboratory work for a large general hospital.

The problem of equipping and developing a laboratory is never a simple one — even in times of peace. The demand for laboratory furniture is not great, and apparatus and many articles have heretofore been imported from France and particularly from Germany. The most difficult problem, therefore, has been to obtain apparatus and reagents in sufficient quantity. The original list of supplies called for an expenditure of about $1200.00 for each of fifty places, and the construction of a special building for laboratory purposes at these hospitals. The principal articles have been delivered at all cantonments and additional supplies are being furnished as rapidly as they can be manufactured. Good men have volunteered and have entered the service in large numbers, and at the present time, it is possible to furnish three to five trained laboratory men to all of the laboratories. In the future, it may be difficult to do as well and recourse must be had to the many trained laboratory workers who have not the degree of doctor of medicine. A way has been provided, through the newly created Sanitary Corps, to use the services of these trained men to the best advantage. In this country, when it becomes necessary, the Army can also use the services of the many highly trained women laboratory workers as civil service employees. Many have already volunteered, and when the time comes, they can help materially in our work in this country.

The character of the work done in these army laboratories will not differ from that done in civil institutions. A manual of technique is being published which will help to standardize the work done in widely separated parts of the country. The work of the laboratories will fall naturally into two classes: clinical pathology for diagnosis in connection with the work of the surgeons and internists in the camp hospital, and public health work for the

sanitary inspectors with the troops, that is, routine water examinations, the examination of carriers of diphtheria, meningitis, and other infectious diseases. One item alone of this public health work will serve to show the large number of examinations which will be required; that is the detection and treatment of the hook worm carrier from the South. Probably not less than a million examinations for hook worm will be necessary if we are to avoid the introduction into France of a new disease. Fortunately the hook worm problem is simple and is well understood, and our only difficulties will arise from the great amount of work required.

Typhoid and the paratyphoid fevers have ceased to be a great problem in themselves, but the mere preparation of sufficient vaccine for millions of men is not a small undertaking. For almost ten years, the Army Medical School has prepared all the vaccine used in the service.

All of the larger places have been equipped to make Wassermann tests, to examine meningococcus carriers, and to differentiate the several types of pneumonia. Standard diagnostic sera for agglutination tests will be furnished from the Army Medical School to any laboratory. In a general way we hope to have the same grade of work done in all the cantonments which is now carried out in the better institutions in the city.

At the present time, we have three principal problems confronting every medical officer of the services: the control of venereal diseases, of pneumonia, and of meningitis; complete and cordial co-operation of all is necessary to achieve success. The army within its camps has developed a fairly effective method of controlling venereal diseases by means of prophylactic treatment and disciplinary measures, which calls for concerted action of both the line officer and the medical officer. Its success will depend upon the care with which it is carried out, and medical officers can contribute materially to the strength of our armies if they will give as much time and care to the treatment of venereal diseases as they are now accustomed to give to less common diseases.

Abroad and at the front, the problem is a little different, and a large number of small, mobile laboratories have been furnished in addition to those furnished each army corps and each army, and to each of the base and general hospitals. In these various institutions, provision has been made, first for the routine work, and second for research, and we may hope that solution of old problems may be simplified, and new problems as they arise may be solved on the spot. Much work has already been done, as you know, on the new diseases of this war.

In conclusion, I wish to say that well trained laboratory men have volunteered throughout the length and breadth of the land to perform laboratory service or any other service for which men were needed. Research and teaching institutions have also offered unanimously the use of their facilities for work and for teaching, and there is everywhere the wish and the will to do everything humanly possible to make our camps and cantonments better than we have ever had them before. All of us who have worked under Surgeon General Gorgas and have learned his methods have come to have confidence in the future of the Medical Corps of the Army under his charge.

EXTRA CANTONMENT ZONES[1]

By RAYMOND B. FOSDICK
Chairman, Commission on Training Camp Activities

THE Commission on Training Camp Activities was appointed by Secretary of War Baker in April, 1917, very shortly after war was declared. Its purpose was twofold: to supply the normalities of life to nearly a million and a half young men in training camps, and to keep the environs of those camps clean and wholesome.

On May 18, 1917, Congress passed the act providing for the National Army. This act declared that prostitution and alcohol were not only not necessary to maintain the efficiency and morale of the Army, but were highly destructive to them. Past experience has proved conclusively that debauchery and loose living among soldiers at mobilization points has in part resulted from lack of opportunities for wholesome amusement. The venereal disease, which has resulted from such misuse of leisure time, has constituted in the past and constitutes today, one of the big problems with which armies must face in maintaining their efficiency. In order to correct these conditions the Commission has devoted itself to the re-establishment as far as possible of the normal relations of life while at the same time delivering sledge hammer blows at those who had mobilized in the communities surrounding such camps for the purpose of exploiting the soldiers by appealing to his baser instincts and passions.

To a great extent the Commission has employed in these two important activities, the machinery of organizations and agencies heretofore interested along such lines. Except where necessary, it has not created any new machinery.

To the Young Men's Christian Association and the Knights of Columbus, for instance, the Commission has looked to supply a large share of the club life and entertainment inside the training camps. To the American Library Association, it

[1] Read by Bascom Johnson, Director, Law Enforcement Department.

has instinctively turned for an adequate supply of books and reading facilities for the troops. To organize the social and recreational life of the communities adjacent to the training camps, the Commission enlisted the services of the Playground and Recreation Association of America which has placed representatives in over one hundred such communities and has harnessed the lodges, churches, clubs, and other local groups and organizations with the men in the camps. So, too, such agencies as the Travelers' Aid Society and the Young Men's Christian Association have been brought into play in connection with the community problem.

Repressive work in dealing with vicious conditions is handled by direct representatives of the Commission, with whom are co-operating such organizations as the Committee of Fourteen, of New York; the Watch and Ward Society, of New England; the Committee of Fifteen, of Chicago; the Bureau of Social Hygiene, of New York; and the American Social Hygiene Association. Local police organizations and sheriffs, as well as the machinery of the Department of Justice and the Military Provost Guards, have been utilized in this work. The special problem arising from the presence of young girls in the vicinity of the camps is handled by the Young Women's Christian Association and by a Committee on Protective Work attached to the Commission.

Within the camps, in addition to the facilities already mentioned, the Commission has appointed sports directors, boxing instructors, song leaders, and dramatic entertainment managers. Theaters are being erected in each cantonment for the exhibition of regular dramatic performances, and special facilities have been provided for the production of moving pictures, vaudeville, and other forms of amusement. Divisional exchange officers, appointed by the Commission, one in each camp, are superintending the operation of the regimental Post Exchanges, or soldiers' co-operative stores.

It will thus be seen that the work of the Commission, both in its constructive and law enforcement activities, constitutes one gigantic piece of preventive medicine. The Surgeon General of the Army has so far recognized this fact as to appoint and delegate to the Commission on Training Camp Activities a number of sanitary corps lieutenants, who are now stationed in the field, and are assisting the Commission in securing the co-operation of communities in this program.

As concrete examples of what has been accomplished may be mentioned the closing of red light districts in the following cities: Deming, New Mexico; El Paso, Waco, San Antonio, Fort Worth, and Houston, Texas; Hattiesburg, Mississippi; Spartanburg, South Carolina; Norfolk and Petersburg, Virginia; Jacksonville, Florida; Alexandria, Louisiana; Savannah, Georgia; Charleston, Columbia, and Greenville, South Carolina; Douglas, Arizona; Louisville, Kentucky; and Montgomery, Alabama. New Orleans has passed an ordinance which will wipe out its red light district on or about November 15. Many cities in which no red light districts were formerly tolerated have, at the instance of the Commission, abolished their open houses of prostitution.

In addition, the laws against vice have been strengthened in many cities at the suggestion of the Commission's representatives, and the machinery for the enforcement of those laws has been geared up to a higher notch of efficiency. In California and Arkansas, State Military Welfare Commissions have been appointed by the Governors of those States, at the instigation of representatives of this Commission, and executive secretaries have been appointed to carry on the work of vice repression.

I am happy to report that in every instance where bad conditions have been brought to the attention of state and municipal officials and the desire of the Government made clear to these officials, that these conditions should be improved, prompt and cheerful compliance with such requests has been forthcoming.

The whole program for the protection of the officers and men of the Army and Navy from the moral and physical contamination of vice and drunkenness depends to a great extent on the co-operation of the medical profession. Much of the misinformation, under which the average man is laboring originated with those doctors, who in the past have advised, and medical quacks who still advise, men that continence is harmful and that seminal emissions result in lost manhood and that regular sexual intercourse is necessary to health.

The exact opposite is the truth, as evidenced by the statement signed by 300 of the foremost physicians of the country, which statement was published in the pamphlet, entitled, "The Physician's Answer," some few years ago. This statement declared that in the opinion of these physicians, there was no evidence in existence that continence was incompatible with health. A still stronger statement was contained in the resolutions of a similar body of physicians called into consultation by the General Medical Board of the Council of National Defense, which statement was embodied in resolutions which were approved by the advisory commission of the Council of National Defense, and finally approved April 21, 1917. These resolutions contained the statement that the departments of War and Navy officially recognized that sexual continence is compatible with health and that it is the best prevention of venereal infections. Two months later the House of Delegates of the American Medical Association unanimously adopted similar resolutions, containing the following paragraphs:

> Therefore, be it resolved, That the American Medical Association endorses the actions of Congress and the Council of National Defense, and commends the following for the basis for a program of civil activities:
>
> 1. That sexual continence is compatible with health and is the best prevention of venereal infections.

2. That steps be taken toward the eradication of venereal infections through the repression of prostitution, and by the provision of suitable recreational facilities, the control of alcoholic drinks, and other effective measures.

These resolutions were passed on June 7, 1917.

In spite of the fact that the vast preponderance of intelligent medical opinion of this country is thus on record that continence is entirely compatible with health, and in fact its only sure guarantee from venereal disease, there are still some doctors, both within and without the service, who believe in the old outworn doctrines of self-indulgence.

Prostitution and its twin brother drunkenness, are fast becoming anachronisms. In a generation we shall probably regard them as relics of barbarism and wonder how any community could ever have tolerated a system which took such terrible toll of health, happiness and life itself — that destroyed the eyes of the newborn babe in the arms of its heartbroken mother — that wrecked the health of that mother and made her unable to bear other healthy children — that filled our insane asylums, jails and hospitals and left behind it a trail of social devastation awful to contemplate.

The winning of this war will depend upon the ability of the allies to maintain their armies at a high standard of efficiency. If the American Army and Navy suffer its personnel to be contaminated by venereal disease, and therefore incapacitated for service to anywhere near the extent that the men of this service have been contaminated and incapacitated in past wars, our service to the cause of humanity will be far short of our hopes, because our forces will be seriously depleted, the war will drag on, and thousands of soldiers and sailors will be needlessly sacrificed before we and our allies can force a lasting peace upon the Kaiser.

We are fighting for the safety of democracy. It is our task also to make democracy worth fighting for. Those who oppose us in our war on vice and drunkenness are attempting to make of democracy a synonym for license and self-indulgence, which in the end always results in anarchy.

We stand for a democracy which, while recognizing man's inherent right to a measure of self-government, insists that that right carries with it obligations to the State, most sacred in character. Those obligations require the individual to curb his passions and exercise self-restraint in order that the institution of the family, which is the fountain-head of the State, and from which spring all of our noblest inspirations, shall remain pure and undefiled. I call upon the medical profession, both within and without the service, to stand by us in this effort to keep the Army and Navy clean and efficient. If social and economic considerations will not suffice to secure this co-operation, I urge it upon considerations of humanity and patriotism.

THE CONTROL OF VENEREAL DISEASES

By Major WILLIAM F. SNOW, M.R.C., U.S.A.
Chairman, Sub-Committee on Venereal Diseases, General Medical Board, Council of National Defense

WAR was declared April 5. On April 17, the Council of National Defense adopted the following resolutions after a hearing participated in by the members of the Council, the Advisory Commission, the General Medical Board, and the three Surgeons General of the United States:

Whereas, venereal infections are among the most serious and disabling diseases to which the soldier and sailor are liable; and

Whereas, they constitute a grave menace to the civil population;

Therefore, be it resolved, That the following recommendations of the General Medical Board be approved for submission to the Departments of War and Navy for guidance:

1. That the Departments of War and Navy officially recognize that sexual continence is compatible with health and that it is the best prevention of venereal infections.

2. That the Departments of War and Navy take steps toward the prevention of venereal infections through the exclusion of prostitutes within an effective zone surrounding all places under their control, and by the provision of suitable recreational facilities, the control of the use of alcoholic drinks, and other effective measures. (By separate resolution, the elimination of alcoholic beverages from camps and surrounding zones was recommended.)

3. That these departments adopt plans for control of venereal infections through special divisions of their medical services.

The first of these recommendations has been carried out through the press and platform on every suitable occasion by the President, the secretaries of War and Navy, the chiefs of staff, and the Surgeons General. Secretary Daniels you heard express his opinion of the importance of this problem last night. Secretary Baker in an open letter to the governors of all the states said:

Our responsibility in this matter is not open to question. We cannot allow these young men, most of whom will have been drafted to service, to be surrounded by a vicious and demoralizing environment, nor can we leave anything undone which will protect them from unhealthy influences and crude forms of temptation. Not only have we an inescapable responsibility in this matter to the families and communities from which these young men are selected, but, from the standpoint of our duty and our determination to create an efficient army, we are bound, as a military necessity, to do everything in our power to promote the health and conserve the vitality of the men in the training camps.

I am determined that our new training camps, as well as the surrounding zones within an effective radius, shall not be places of temptation and peril. . . .

Will you give earnest consideration to this matter in your particular state? I am confident that much can be done to arouse the cities and towns to an appreciation of their responsibility for clean conditions; and I would suggest that, through such channels as may present themselves to you, you impress upon these communities their patriotic opportunity in this matter. I would further suggest that as an integral part of the war machinery your Council make itself responsible for seeing that the laws of your State and of Congress in respect to these matters are strictly enforced. This relates not only to the camps established under Federal authority, both the present officers' training camps and the divisional training camps soon to be opened, but to the more or less temporary mobilization points of the national guard units. It relates, too, as I have indicated, to the large centers through which soldiers will constantly be passing in transit to other points.

As early as 1915, Admiral Braisted prepared for the Navy with the approval of the Secretary, a program essentially along the lines now under consideration. Surgeon General Gorgas, in a recent address, said:

It is the purpose of all the military medical establishment to direct its efforts toward keeping as many men as possible for as long a time as possible in the fighting force. Obviously, therefore, the medical department of the army is deeply concerned in every effort of education, recreation, law enforcement, and treatment which will reduce the non-effective rate of venereal diseases. These four lines of attack constitute the basis for the program of combating these diseases which will be carried out by the army. It is hoped that the civil authorities will simultaneously place the same program in operation.

In another statement issued by the Surgeon General's office, it is pointed out that "neither the measures within the military establishment nor the supplementary measures in specified zones can achieve the largest success without the full co-operation of civil authorities in enforcing such equivalent measures in all communities accessible to the personnel of the army. These are but illustrations of the efforts of every chief government officer concerned to place this problem and its solution squarely before the American people.

The second of the original recommendations has been met by Congress through empowering the President and Secretary of War to establish zones about military camps and to make regulations for the elimination of prostitution and alcohol therefrom.

The third recommendation has been met by the creation of the following administrative facilities:

1. Commission on Training Camp Activities;
2. Section on Venereal Diseases of the Infectious Disease Division of the Surgeon General's Office;
3. Advisory Committee on the Treatment of Genito-Urinary and Venereal Diseases. (The Navy deals with this problem through its Bureau of Hygiene and Sanitation.)

The Commission on Training Camp Activities directs every effort toward preventing exposure to infection; the Surgeon General's office directs every effort toward preventing the development of infection or the ravages of the diseases and transmission to others by infected men.

There remains the civil profession's part; namely, similarly to control the carriers in the communities. It is to this task that the Committee on State Activities is addressing itself in an effort to arouse the medical profession of America to its responsibility in combating this last of the great plagues which take their toll of human lives and happiness practically unchallenged.

The reading of a letter adopted this afternoon for sending to the State Committees best outlines the civilian program to be advocated:

To give effect to the application of the venereal disease program, the following syllabus of administrative details should be promulgated:

1. The reporting of cases of syphilis and gonococcus infection to the health officers of jurisdiction should be immediate and under the following conditions:

a. The physician may report each or any case by a key number instead of the name, provided he declares himself responsible for instructing the patient in the methods of preventing dissemination of the disease, insuring proper living and working conditions, securing the examination of exposed members of the patient's family or associates, and for inducing the patient to accept continuous treatment and supervision until no longer a carrier; provided further that he agrees to report promptly to the health officer the name and address of each patient who does not fully carry out the instructions given him.

b. The physician may report each or any case by name and address upon beginning treatment, provided the patient is told that such reporting will be a condition of the physician's attending the case. Under these conditions the health officer becomes responsible for instruction of the patient and protection of the community.

c. The health officer must observe the same professional care in protecting the patient from publicity that is exercised by the private physician and will proceed with investigations of suspected foci of infection and the isolation of infectious persons with due regard for protecting the rights of individuals, it being understood that all records are confidential and not open to the public.

2. The reporting of sources of infection to the health officers of jurisdiction under the following conditions:

a. The acknowledged prostitute must be reported by name and address.

b. An infectious person who is not a prostitute may be reported by a key number, provided the physician can assure the health officer that such person is under treatment, and give the name of the attending physician if not himself treating such patient at the time.

c. The patient who knows the source of his infection but desires to avoid giving the name and address to his physician may provide evidence that the carrier has actually come under treatment by a physician or clinic.

3. The reporting of monthly summaries of cases under treatment, and epidemiological data required by the health officer:

a. The physician must report monthly on forms supplied him by the health officer, the number of cases of syphilis and gonococcus infections he has treated, together with such data as may be useful in combating these diseases through general administrative measures.

b. The physician who fails to comply with rules and regulations for the combating of venereal diseases may be

debarred from the privileges of laboratory diagnosis, salvarsan, and other supplies in addition to any penalties provided by law.

4. The provision of free laboratory diagnosis aids for both syphilis and gonococcus infections, at state, city or private expense.

5. The provision of advisory stations for both men and women, where information concerning syphilis and gonococcus infections may be obtained and clinical examinations may be made when necessary.

6. The provision of adequate dispensary facilities.

7. The provision of adequate hospital facilities for patients requiring hospital care for their own welfare or the protection of others.

Where the isolation of such carriers is found necessary, the hospital treatment should be intensive and at public expense.

8. The provision of an adequate supply of free salvarsan or its equivalents and of other drugs required in the treatment of syphilis and gonococcus infection cases, available under conditions which may be specified by the health departments for physicians, dispensaries, and hospitals co-operating in shortening the infectious period of cases reported by name and address.

9. The provision of pamphlets, cards and instruction, form letters for follow-up of indifferent patients and other devices for assisting the physician in complying with the requirements of the health department.

10. The enactment of any necessary laws, ordinances or regulations for promoting the reporting and proper treatment of syphilis and gonococcus infections; for protecting the physician from damage suits in complying with such regulations; for eliminating the medical charlatan from this field of medicine; for limiting the druggist to dispensing prescriptions for these diseases written by registered physicians; for protecting the privacy of all reports and records.

11. The co-operation of all civil authorities in dealing with syphilis and gonococcus infections on the same basis as that for other communicable diseases. To this end the assistance of the medical profession is valuable in investigating suspected foci of infection, examination of male and female prisoners charged with disorderly conduct or vagrancy, the checking of the migration of carriers from one community to another, and above all the education of their patients and the public upon the causes and consequences of these diseases.

12. As a special war measure, the agreement of all physicians to refuse to treat men or officers in uniform without reporting the fact to the proper military medical officer, and to co-operate in every way in promoting the government's program for lowering the non-effective rate from venereal diseases among the Army and Navy personnel of the United States.

As a further special measure for the period of the war, the committee on state activities recommends the appointment of qualified specialists in the treatment of syphilis and gonococcus infections as advisory committees to the state and municipal health officers; the activities of such advisory committees to be correlated by the joint supervision of the State Defense Council Committees on Health and the State Committees of the Medical Section of the Council of National Defense.

In order to avoid any possible misunderstanding that may arise as to the attitude of health officers on the question of the toleration by or indirect acquiescence in vice by health departments, which has sometimes followed such medical inspection and treatment, co-operation should be offered and given by health officers and physicians to state or municipal officials and citizens who are responsible for the repressive law enforcement measures against commercialized vice.

Almost twenty years ago, our beloved and honored Surgeon General stood before the task of eradicating yellow fever, yet he did not flinch nor avoid his responsibility; today he stands before this great preventive medicine problem, and does not flinch nor avoid his responsibility. It is for you, the leaders of the medical profession of America, to follow his example.

GENERAL SURGERY

By Major CHARLES H. MAYO, M.R.C., U.S.A.

IN this great war, which is pre-eminently scientific in every department, as it has been fought in the air, on earth, and in and under the water, medicine feels very proud of its achievements. Only through medicine has it been possible, with the enormous numbers of men in the field, to carry on the war for three years. Had it not been for medical efficiency, the war would have been terminated long ago, from the same causes which have terminated wars in the past; through disease and infection. We would possibly have had brought upon us a very unsatisfactory peace, which would be far worse than no peace at all. Through medical efficiency, the war will be carried on to a final termination which will end the wars of the present age, and democracy will be safe in the world.

When war was first declared, the medical men of our country responded to the cry for aid; to the call of humanity. Probably two thousand of our profession have been at work in England; hundreds have helped in France, in Serbia, in Russia, and in Italy, and also I might say, some few hundred in Germany. We have thus among us men who have gained the intelligence derived from more than three years' of work, and this is a great aid to the Surgeon General.

We feel very proud that after war was declared, the first contingent representing the United States to go abroad was a medical one headed by Major George W. Crile.

We are proud, from a medical standpoint, but not from a humanitarian standpoint, that Germany recognizes us by dropping bombs on our hospitals, we are proud too that we are returning in excess of 80 per cent of the injured back to the front.

It is unfortunate that the medical profession has not quite the rank to accomplish the things that today we are able to accomplish, that our people are very much opposed to making changes in rank, and still hold to the rules established during the War of Independence. One remembers that Washington did not even become a general; that Grant did not become a general until after the war; and then it was an act of Congress that gave him the rank as a reward of merit. So also was Sherman made a general and Sheridan; and now two more have received the rank. It is extraordinary that this great country, as rich as any two countries in the world, should base rank and the honors for work done in this war on the old time standards.

We cannot go from this country, either as medical or army officers with a rank which befits us properly to associate with the men representing France and England, who are doing the same work. It is to be hoped that this subject will be properly adjusted when the new Army of the United States is formed.

A few years ago the Medical Service in the Navy was largely a contract service. This has been changed and in the first six weeks after war was declared, the entire Medical Service of the Navy was filled, and the officers rank with those of any other country in the world. The Army should receive similar recognition, not alone the Medical Department, but the entire Army.

It is fortunate for our country, for our soldiers, and especially for the medical men, that we have in charge such a great man as Surgeon General Gorgas who is held in the highest possible esteem by the medical men of our country. Congress has honored him by bestowing upon him the rank of Major General, a rank higher than that given to the Chief of the Medical Service of our Army.

As has been stated, before the war Surgeon General Gorgas' office consisted of only a few rooms. Now, in one building there are more than one hundred and fifty doctors in uniform; there are five hundred and fifty clerks, and there is an overflow into two more buildings.

So you can realize the fact, some of you who have been delayed receiving your commissions, that there has been carried on a tremendous amount of work in the Surgeon General's Department, in the handling of sixteen thousand medical men. In order properly to place the applicants, it was necessary to find out much concerning them as to their qualifications and standing, and to plan for their military and special medical instruction when the time came to take care of one million eight hundred thousand men in the camps, for the same conditions would have to be anticipated in the camps as in any community of 30,000 to 75,000 people. The Surgeon General, with the aid of the various advisory departments in his office, has been able to put on the staffs of these hospitals, of five hundred to twelve hundred beds, eminent surgeons and professional men of the various specialties, many of whom have been secured from our medical colleges, universities, and large hospitals.

The Surgeon General, with the aid of his department officers, has developed the greatest post-graduate school of medicine in the world.

Unfortunately, many of our best medical men, of our best surgeons, fail to realize the necessity of any military training; yet most will admit the lack of the medical man's training in business and admit the necessity for accurate and uniform reports.

No measures are sanctioned in the Surgeon General's office except those which have stood the test of practice, and have been approved in the medical reports of the three years of warfare.

Some curious and false statements have been made as to the specialists. The specialists are doing a great work in the Surgeon General's office, but they are going to do exactly the same work there that they have done in civil practice in the history of medicine in our country.

Modern medicine is now too great a study to be compassed by one man, except in communities too small to support specialists. The Surgeon General has, at his command, prominent representatives of the various specialties at the head of departments and sub-departments, Many of the specialists in the Surgeon General's office have done much in advancing American medicine to the high plane it now occupies.

The records which have come back to us show that in "Over the Top" fighting, about 10 per cent receive head injuries of some sort, that in trench warfare, possibly 20 per cent receive such injuries. There are about 10 per cent of chest injuries, about 6 per cent of abdominal injuries, and 25 per cent of the total cases on the average are fractures. A very large amount of the work is, therefore, classed as general surgery.

The Surgical Unit then consists of a man, the surgeon, up at the front giving his first aid, doing the best he can with few conveniences; the field hospital; farther back the clearing stations; and, finally, the base and special hospitals.

The work of the General Medical Board of the Council of National Defense in charge of Major Franklin Martin, is of the greatest value to the Surgeon General's department. Through this Board is developed medical investigation and committee detail work, which upon completion is turned over to the Surgeon General for action. Major Frank Simpson is a member of a sub-committee of that most important committee of purchases and supplies. This committee co-ordinates the needs of the Department and through it is secured information concerning supplies, their cost, availability, and manufacture.

HEAD SURGERY

By Major WALTER R. PARKER, M.R.C., U.S.A.
From the Division of Surgery of the Head, Office of the Surgeon General, U. S. A.

COLONEL LYSTER, who was to speak to you tonight has been detained in Washington on duties incident to the war. In his absence the Surgeon General has directed me to represent him on the program and to speak of the activities of the division of Surgery of the Head. Before taking up the discussion of the subject assigned me, I wish to express to the President and members of the Clinical Congress of Surgeons, Colonel Lyster's appreciation of your invitation to appear on the program, and his sincere regret that he cannot be present and speak to you on the subject in which he is so keenly interested. He also requests me to voice his appreciation for the advice given and the assistance rendered him by the Sub-Committee on Ophthalmology of the Council of National Defense.

The sudden expansion of the Medical Corps of the Army by the incorporation of civilian physicians and surgeons necessitated the consideration of new problems. One of the first problems to be considered was, to determine how to give the Army the benefit of the services of those trained in a special branch of surgery, and, at the same time construct the necessary organization to make them effective from a military standpoint.

At the beginning of the war it became the policy of the Surgeon General to utilize as far as possible the services of the surgeons in the line of their specialty. One of the steps in carrying out this policy was the grouping of those specially qualified, into a unit to be known as Division of Surgery of the Head. The specialties which form this group are ophthalmology, oto-laryngology, brain surgery, and oral plastic surgery of the face. As soon as this policy became known the specialists of the country dropped their reluctance to enter the service and willingly accepted commissions in the Medical Reserve Corps.

In the office of the Surgeon General this Division as a whole, is under the direction of Lieutenant Colonel Lyster of the Regular Corps and to each sub-section is assigned a member of the Medical Reserve Corps.

The first duty of the division of the Surgery of the Head was to secure for the Surgeon General the names of a sufficient number of physicians qualified to do the work, who were willing to serve. In some instances, notably in brain surgery and oral plastic surgery there were not enough trained men available to meet the demand. To meet this emergency schools have been established where preliminary training is given. Details of this plan will be given later.

Through the activities of this division 589 officers of the Medical Reserve Corps are now on duty, or ready for service. The number who have signified their willingness to serve is more than twice that number. Should the war necessitate the training of an army of three millions of men, it is estimated that the number of surgeons required by this section alone will be 3043.

The medical profession has responded so liberally to the call for service, that the Surgeon General may reasonably expect to be able to furnish that number when the time comes.

Another special duty of the division has been

to suggest plans and equipment, and to advise on the personnel for a special Head Hospital with a capacity of 1,000 beds, authorized by the Surgeon General to be erected and operated somewhere in France at the proper time. In this hospital will begin the first work of reconstruction.

It is the purpose of the Surgeon General to establish schools of instruction for all the surgeons in the Cantonment Hospitals. To assist in this work teachers of known reputation have been assigned to take charge of the various divisions and textbooks dealing with the military aspect of each department are being prepared.

The spirit shown by the men assigned to duty in a National Army and National Guard Cantonment hospital who have had to contend with the discomforts incident to the development of a camp, has been all that could be desired. In no single instance has there been the slightest indication that they did not realize the emergency and make the best of the situation.

In a few instances requests for a higher rank have come to the heads of the various divisions. It can be said, however, that only in rare instances has service been refused because of the commission offered. It is not the province of this division to issue commissions. The Surgeon General authorizes me to say that it is the policy of his office to give the higher rank to those of large experience who, on entering the service, are qualified to assume full control of the special surgical service to which they have been assigned. To those in the lower grades, it can be assured merit will be recognized and promotion given whenever it is fitting to do so.

If it is proper at this time, I shall as a Reserve Officer take advantage of this opportunity to acquaint the members of the medical profession with the consideration shown by the Surgeon General and his officers of the Medical Corps. Our inexperience in military affairs frequently leads to inconvenience if not confusion. All the officers have been untiring in their efforts to set us right, and to assist us in the performance of our various duties.

BRAIN SURGERY

By Captain CHARLES BAGLEY, Jr., M.R.C., U.S.A.
Chairman, Sub-Section of Brain Surgery, Division of Surgery of the Head, Office of the Surgeon General, U.S.A.

THE difficulty experienced by the average citizen in estimating the gravity of the present war is proportioned to the magnitude of the struggle. Many citizens seemingly entirely satisfied to leave the whole problem to others, have, however, quickly responded when requested to perform a personal duty in the giving of advice, money, or even life. In the same way, the physicians in common with others, failed to appreciate the full force of duty, until their great work was divided into small parts. The announcement by the Surgeon General of the Army that the medical department was to be divided into various special sections, demonstrated clearly the responsibility of the individual doctor. In focusing carefully upon the special section of brain surgery, one is able to outline the responsibilities of a small group of surgeons and find the way for them to do their full part.

The wounds of war surgery of the nervous system may be classified as follows:

1. Tangential wounds, in which the missile, usually a rifle bullet, has passed superficially to the bone, leaving its mark externally in the form of a gutter, with or without fracture or intracranial complication.

2. Penetrating wounds, in which the missile has passed immediately beneath the bone. In these cases the laceration of the dura and brain is, naturally, inevitable. Bone fragments may penetrate more or less deeply.

3. Direct localized blows by fragments of shell or shrapnel bullets, which have themselves failed to penetrate the skull, but nevertheless have driven fragments of bone deep into the brain.

4. Penetrating wounds in which a missile has entered and remained lodged in the brain substances.

5. Cases in which a rifle bullet has passed across the cranial cavity, the wounds of entry and exit being on opposite sides of the head.

6. Concussion of the spinal cord, in many instances not associated with external signs of injuries.

7. Compression of the spinal cord when a detached spicule of bone is driven into the spinal cord, these injuries frequently differing only in degree from those produced directly by a projectile.

8. Direct localized injuries resulting from fragments of shell or shrapnel, in which there may be extensive local destruction and often a considerable amount of blood clot.

9. Wounds or injuries of the peripheral nerves, of varying degrees, again divided into a small group in which the nerve injury is of primary importance, and a much larger group in which the injury of neighborhood structure is of far greater significance.

The problems in the care of this varied group of injuries may be summed up as follows:

1. To reduce to a minimum that large group of cases likely to end fatally within the first twenty-four hours; this to be accomplished by combating shock, and through what early revisional operative work may be indicated.

2. By combating infection. We have been told that as civilization has generally been dragged backward by the present war, so surgery has been dragged from the pedestal of aseptic to the mire of antiseptic surgery. This is, to neurological surgery, a serious blow, since the advances made in this branch during the past few years have had to do chiefly with cases falling in the aseptic group. In fact, we have been so defenseless in the battle against sepsis in surgery of the central nervous system, that little attempt has been made to combat such common diseases as meningitis.

3. The removal of foreign bodies, or the searching for needles in the haystack. We are told that many foreign bodies lie superficially, but patients with missiles deep in the substance of the brain do reach the surgeon and must be intelligently handled. The X-ray is of tremendous assistance, not only in the localization, but also in directing the removal of fragments. The giant magnet, so valuable in the handling of most of the metallic foreign bodies, has a limited value and is capable of great harm. The multiplicity of these foreign bodies is perplexing and has resulted in many being left behind after an apparently complete operation, to excite encephalitis, abscesses, fungi, and sterile traumatic cysts.

4. Herniæ cerebri. In a survey of the literature, numerous articles are found describing methods of treating herniæ cerebri, and one is again impressed with the backward trend of neurological surgery. Many soldiers have died or have been seriously crippled as a result of this lesion, in spite of the fact that for several years prior to the war not a single complication of this sort occurred in the largest surgical neurological clinic in this country.

5. Bony defects of the skull, and "crippled brains," are not of immediate importance, but are here mentioned since they indicate to a small degree the tremendous problem of reconstruction which will fall to the division of brain surgery after the war. In passing, I simply mention epilepsy, with an earnest plea that every possible effort be made to reduce its occurrence.

After thus grouping the work, we are confronted with the fact that there are very few neurological surgeons. The lack of special surgeons cannot be accepted as final, any more than was the diminutive size of our standing army at the outbreak of the war. The very small corps of neurological surgeons must undergo the extraordinary expansion now so conspicuous in all branches of the service. In what way can this emergency expansion be accomplished in the short time at our disposal? Let us begin by grouping our facilities:

1. We are in possession of a special technique peculiar to surgery of the nervous system.

2. We have a small group of surgeons who possess this special technique; some of this group have already entered the field in France; a number of others are still in America, many of them carrying on their usual duties of civil life.

3. There are numerous laboratories and clinics, all at the disposal of the Surgeon General of the Army.

4. The literature is filled with the surgical experiences of our Allies, and this, too, is easy of access.

5. A great many surgeons who have had good training and possess excellent judgment, many of them already in the Medical Reserve Corps of the army, are capable and willing to undertake this special work if given an opportunity further to fit themselves.

The first step in the expansion of the corps necessarily consisted in combining the teachers, as represented in group two, and the students of group five, by utilizing the teaching facilities of groups three and four. With this end in view, a conference of the members of group two was held in Washington, July 27, followed by similar conferences at later dates. When the needs were placed before the members of this conference, it was evident that their services and all the facilities of several universities were at the disposal of the Surgeon General. A plan was outlined with the aim in view of securing about 250 carefully selected candidates for neurological surgery from the large number of surgeons of the United States. To this end a letter, requesting the names of surgeons qualified to undertake the work, was addressed to 150 large hospitals and to members of consulting boards appointed in every state of the Union. As a result, about 700 surgeons were nominated. A questionaire addressed to these surgeons has resulted in about one-half of the required number signifying their willingness to accept service in the Medical Reserve Corps and to be classified in the division of brain surgery. The training of these surgeons has been undertaken in a school established at the University of Pennsylvania, under the direction of Dr. Charles H. Frazier, with the assistance of such able men as Dr. Spiller, Dr. Dorrence, Dr. Ludlam, Dr. Weisenberg, Dr. de Schweinitz, and Dr. Miller. Plans are now complete for the establishment of a similar school in this city, under the direction of Dr. Dean Lewis, and with the assistance of Dr. Bensley, Dr. Carlson, Dr. Halstead, and Dr. Herrick. A school will later be established in St. Louis under the direction of Dr. Ernest Sachs, and another in New York under the direction of Dr. Charles A. Elsberg. The course is so arranged as to deal particularly with the fundamental subjects, such as anatomy, physiology and symptomatology of the nervous system. The necessary military training is being given in the various cantonment hospitals and training camps.

After receiving intensive fundamental training, these surgeons will be capable of special clinical training in Europe. Again, we wish to make use of the available time, and of the service of the leaders of neurological surgery, already in France, by establishing a school in the war zone. The definite details of this school, it is hoped, will soon

be completed by an officer of the section of Surgery of the Head, now on his way to France. After the completion of the training, the surgeons will be assigned to the various hospitals according to the exigencies of the service.

With a view of placing before the surgeons enlisted in the division of brain surgery, the essential neurological knowledge contained in numerous textbooks and current medical literature, the Surgeon General authorized the publication of a book. With the co-operation of the library of the Surgeon General, and the various authors and publishers mentioned in detail in the preface, Major M. G. Seelig has completed *War Surgery of the Nervous System*, a compact volume of 360 pages. The book has stimulated active interest in neurological surgery, since the complex subject matter has in this way been condensed.

Because of the large percentage of infected wounds and the lack of knowledge of combating infection of the brain and spinal cord and their coverings, animal experimentation has been undertaken with the hope of determining:

1. The best methods of draining of the subarachnoid space.
2. The effect of mechanical washing of the space; and
3. The reaction of the nervous tissues to the various chemical reagents.

Under the direction of Lieutenant Lewis H. Weed, this work has been carried on for two months. At this date he can only report progress and promise a more detailed report in a few weeks.

The problem of neurological surgery, though only a small part of the combined work of the medical department, is too great to be accomplished without the full help of the medical profession. For over three months we have been steadily compiling a list of candidates, and are still in need of surgeons.

The work must be undertaken in an unselfish and self-sacrificing manner, but, if properly done, the compensation upon completion may be summed up as follows:

1. To the individual soldier, the best service;
2. To the medical department of the army, a small part of the great task, well done;
3. To scientific research the advance that will necessarily come if all specimens are carefully preserved and correlated for postbellum study.
4. To the civilian population all the advantages incident to the wider dissemination of a broader surgical knowledge.
5. To the individual surgeon, active in the work, the satisfaction of having done his part.

OPHTHALMIC SURGERY

By Major JAMES BORDLEY, Jr., M.R.C., U.S.A.
Chairman, Sub-Committee of Ophthalmology, General Medical Board, Council of National Defense

DR. FRANKLIN MARTIN has requested me to outline for the Clinical Congress of Surgeons the work of the Sub-Committee on Ophthalmology of the Council of National Defense.

This committee was authorized on April 26 and on May 13 made its first report to the General Medical Board. Since then without the intermission of a single day, it has been in Washington working in an advisory capacity on the many ophthalmological problems of the Army.

The committee's activities have been so varied that only the most important can be considered tonight.

A complete catalogue of the nearly 9000 ophthalmologists in this country, embodying the age, training and experience of every man, has been prepared. After eliminating those who as teachers, individual workers in dependent communities and men of small means and large family responsibilities, we have been able to hand to the Surgeon General the names of over 1400 men who have signified their willingness and are qualified to serve. Of this number more than 300 have been commissioned and more than 200 ordered to active duty.

We have studied the Surgeon General's plans for the organization of the army hospitals and where requested have made suggestions as to their personnel and the equipment necessary for eye work in the various establishments. We are delighted to say that many of our suggestions have met the Surgeon General's hearty approval, and we feel that when the American Army is in the field the Surgeon General's plans for ophthalmic service will be found adequate.

At the request of the Editorial Committee of the Council of National Defense, a small book has been written, the title of which will be "Ophthalmic Military Surgery with Chapters on Trachoma and Malingering." The visual requirements for the various services of the Army have been submitted to us for study and suggestions. The glass which has been recommended for protecting goggles for aviators, ambulance drivers and soldiers has been submitted to us for investigation. In response to a request we have suggested a glass which possesses a selective absorption of light waves for use in binoculars, field glasses and range finders.

We have caused to be manufactured for the first time in the U. S. the soda glass necessary in the manufacture of glass eyes which heretofore has been manufactured exclusively in Germany. A member of this committee acting independently has devised a plan for protecting eyes against injury which we believe will be of far-reaching value.

Discovering early the need for co-ordination in the work of all surgeons dealing with injuries to the head we suggested the formation of a sub-committee on Oto-Laryngology. After their organization we joined forces, and at the suggestion of this joint committee the General Medical Board added to the personnel a brain surgeon and an oral face plastic surgeon. This enlarged committee is known as the Committee on Surgery of the Head.

In the Surgeon General's office there is a "Division of Surgery of the Head," about which Major Parker has spoken. In order to co-ordinate the organization work of the Army Division and the advisory work of the Council Committee the Surgeon General has placed in his office, Division Surgery of the Head, several members of the Council Committee, and Lieut.Col. T. C. Lyster, chief of the Division of Surgery of the Head in the Surgeon General's office has been appointed a member of the Council Committee.

It is the Surgeon General's desire that we shall continue our work and with this end in view he called a member of the Committee into active service and assigned him to the division of physical reconstruction and re-education to assist Major King, the chief of the division, in preparing plans for the re-education of blind and deaf soldiers.

Major King who is charged with this vast problem is tireless in his efforts to arrange a comprehensive plan and he seeks the best advice obtainable. With this very proper perspective he called together a group of twelve of the leading educators of the blind in this country to have them study with him this complex question. These educators not only know the problems which confront the blind in this country but they are likewise thoroughly familiar with the work of the English and French in this war. On their suggestions Major King has arranged for the field service in France and for the establishment of a teaching institution in this country. A very patriotic and generous lady has placed at the disposal of the Surgeon General her very beautiful country estate to be used for the latter purpose.

Everyone who has given thought to the subject of re-education of the injured soldier knows that it is essential for the Army to hold him in the military service until his re-education is completed. In order to do this, the Surgeon General must have supervision over every stage of the process. Indeed it is essential that the organization which will have the responsibility of the placing of an injured soldier in a trade or profession should likewise be directly under the Surgeon General who is charged with the duty of preparing that man physically for the battle of life.

This is in brief the general scheme and into it fits the blind soldier who must first, if possible, be reconstructed ocularly and if not, then re-educated and placed in such a position that his future happiness will, as far as possible, be assured.

I cannot close without expressing the high regard of the Sub-Committee of Ophthalmology for Surgeon General Gorgas who has always welcomed our suggestion, who has always found pleasant tasks for us to perform and who ceaselessly works for the upbuilding of his very important Department. Nor would I close without saying that the individual members of this Committee will forever thank Dr. Franklin Martin and the General Medical Board for the wonderful opportunity he has offered us to serve the Army and the Nation.

ON SURGERY OF THE EAR, NOSE, AND THROAT

By C. W. RICHARDSON, M.D.
Chairman, Oto-Laryngological Sub-Committee, General Medical Board, Council of National Defense

ON March 19, 1917, the Presidents of the American Otological Society, the American Laryngological Association and the American Laryngological, Rhinological and Otological Society were requested by the General Medical Board of the Council of National Defense to appoint a committee to advise the Council to what degree and in what activities these specialties could be made available in the event of war being declared. The three societies above mentioned appointed Dr. Burt R. Shurly of Detroit, Dr. Harris P. Mosher of Boston, and Dr. Charles W. Richardson of Washington as members of this committee. Each member of the committee is an active member in all three of the above mentioned societies. This committee met in Washington on March 24 and 25, 1917, and after due consideration formulated answers to queries suggested, and forwarded them to Dr. F. F. Simpson, Chief of the Medical Section, Council of National Defense. It was not until June 22, that the committee was called before the General Medical Board to present a formal request for its incorporation as a sub-committee on the nose, throat, and ear of the surgical specialties.

The Executive Committee at its meeting, Monday, June 23, authorized the committee to commence its activities. With the formation of the Sub-Committee on Oto-Laryngology, its membership was made up of Lieut. Col. Theodore C. Lyster, Surgeon G. E. Trible, U. S. N., and the three members of the original committee. Dr. Charles W. Richardson was elected chairman.

The first activity engaged in by the committee was the listing of all the known specialists in this branch of medicine throughout the United States, and preparing an index catalog. Through this

means we have discovered that 852 men were available for service. Of this number 43 oto-laryngologists have been assigned to National Army Cantonments, 34 oto-laryngologists have been assigned to National Guard Cantonments. The number of oto-laryngologists listed as eligible, that is, who have accepted their commissions and are awaiting assignment to duty is 149. The number of oto-laryngologists who have not accepted their commissions, but to whom commissions have been granted is 44. The number of oto-laryngologists who have been assigned to go abroad is 32. The number of oto-laryngologists who have signified their willingness to accept service, but have not yet taken out their application papers is 852. The number of oto-laryngologists estimated as needed for purposes of expansion is 750. Many of these men are now in the Medical Officers Reserve Corps, and before long all will have accepted commissions.

Our method of cataloging and card indexing has followed the system inaugurated by the Sub-Committee on Ophthalmology, to whose chairman, Major Bordley we are indebted for many suggestions.

On July 15, in conjunction with the Sub-Committee on Ophthalmology, we were able to place one of our members, Major H. P. Mosher in the Surgeon General's Office, under Lieut. Col. Theodore C. Lyster, chief of the section of Surgery of the Head. Through this opportunity we were enabled to get in closer relations with the Department, and thus do much more efficient work. Early in July, the General Medical Board granted permission for the Ophthalmological and the Oto-Laryngological Sub-Committees to meet in joint session. One of the first results of these meetings was the creation of the Surgical Head Unit. This unit consists of ophthalmology, oto-laryngology, brain surgery, and oral and plastic surgery. The brain surgical element has become a constituent of the Ophthalmological Sub-Committee, and the oral and plastic element has become a constituent of the Oto-Laryngological Sub-Committee. Weekly meetings of the surgery of the head committee are held. Four representatives of the committee have permanent positions in the Section of Surgery of the Head, under Lieutenant Colonel Lyster in the Surgeon General's Office. Other activities of this committee have been the standardization of oto-laryngological instruments; in aiding the Surgeon General to assign the proper personnel to cantonments and base hospitals; the revision of hearing requirements for entrance to the Army; the assembling of tests for malingerers; and the near perfection of an ear protector. The committee on Oto-laryngology has planned a special hospital and dispensary building for the Section of Surgery of the Head for the National Army Cantonment and for the base hospitals abroad. All of these activities have received the approval of the Surgeon General. At present a manual of war surgery of oto-laryngology is being prepared by Major Hanau W. Loeb of St. Louis, at the request of the committee. During the month of August several trips were made by members of this committee to various cities, in order to explain to oto-laryngologists the activities of this committee, and awaken interest in the members of this branch of medicine to their opportunities for service. Reports have also been sent out by this committee through the secretaries of the national oto-laryngologic societies to all of their membership, outlining the activities of this committee. Through the presence of Major H. P. Mosher in the Surgeon General's Office, we have been enabled to suggest to the chief of the personnel bureau the appropriate grade to be assigned to various officers receiving commissions. In this work we have been ably assisted by our advisory committee, members of which are our best known oto-laryngologists in each of the states of the Union. The names of candidates unknown to the committee as to their professional qualifications are referred to the advisor in the state from which the candidate comes and an accurate account of his qualifications is thus obtained. We have also been enabled to suggest the names of the men to be assigned to each of the cantonment special hospitals. It is almost needless to state that all the majors in charge of these hospitals are men famous in this special line of surgery and their assistance almost as well known in our specialty. We are now preparing a roster of the men to be placed in the base hospitals abroad. Through the assistance of one of the members of this committee a legislative act was so shaped as to assure the reconstruction of the soldier and sailor to these arms of the service. The reconstruction re-education and rehabilitation of the defective in hearing and speech among the soldiers is receiving due consideration by this committee. On September 29, a meeting of physicians interested in and educators of the deaf was held in Washington, and as a result of this meeting a preliminary report was made by Major Bordley, who represents the Section of Surgery of the Head in the reconstruction bureau under Major King. A second report has just been prepared indicating the various steps by which the objects sought may be attained. In the last week there has been a change in the Committee, Dr. Burt R. Shurly having resigned in order to accompany his unit abroad, and in his place the Council of the American Laryngological Association has nominated Dr. Joseph H. Bryan of Washington, D. C., to the Council of National Defense, as a member of this Committee. Dr. Harris P. Mosher having been ordered abroad, his place is now occupied by Dr. C. W. Richardson in the Section of Surgery of the Head.

I wish to express the appreciation of this committee for the unfailing courtesy and kindness of our Surgeon General, and also of the various administrative heads in his department; and further to express the appreciation of the committee for the courteous, kind co-operation and advice of the chairman of the General Medical Board of the Council of National Defense, Dr. Franklin H. Martin.

THE AIMS OF THE SUB-SECTION OF PLASTIC AND ORAL SURGERY

By Major VILRAY P. BLAIR, M.R.C., U.S.A.
In charge of the Sub-Section of Plastic and Oral Surgery, Section of Surgery of the Head, Office of the Surgeon General, U.S.A.

OF not uncommon occurrence in the present war are those distressing wounds of the face and jaw bones which have attracted particular attention, not only on account of the disfigurement which they cause, but even more so from the difficulty that was at first encountered in dealing with them. This difficulty is the logical outcome of an attitude that regarded dentistry and surgery as two distinct and separate professions. As long as this theory was allowed to dominate practice, a man who had an extensive injury of the face and jaw bone had about as much chance for an ideal result as had the man with an open fracture of a limb in the days when the physician and the bone setter could find no common ground upon which to meet. The bone setter, and the physician who refused to recognize the surgeon, are of the past, but the surgeon and the dentist in their relation to each other only too frequently perpetuate the agnosticism of those older practitioners.

It is now accepted as axiomatic that in dealing with an open fracture of the thigh, the fixation of the bones and the treatment of exposed tissues should be concurrent, and that early treatment is one of the most important factors. It is not universally recognized that these same principles hold in the treatment of a wound involving the jaw bone and the soft tissues, whether it be the result of an industrial accident, a removal of a tumor, or a war injury.

The surgeon has expended much study upon making himself master of the various means of splinting an injured limb, but proper fixation of a fractured jaw can only be done by the use of dental splints. These he cannot apply himself, and he has not always sought the help that the dentist could so easily lend.

The late von Langenbeck after the War of '70-'71 said "I would not care to go through another campaign without the help of skilled technicians to aid in the care of these jaw injuries."

The surgeon is not technically trained to splint these cases, yet early proper fixation is one of the most important points of the treatment. The dentist as such is not trained to care for the wounded tissues beyond fixation of the bones, yet repair of the soft tissues and proper drainage may be equally important. A few have bridged this no man's land between surgery and dentistry, recently a much larger number have learned co-operation, but today I believe that the majority are pursuing their separate ways, that a patient with a jaw injury will be treated either by a surgeon or a dentist neither of whom is master of all of the problems, and that either the fixation or the care of the tissues will suffer accordingly.

I crave pardon for injecting a personal note to the extent of begging that nothing be interpreted as the slightest criticism of the men who have been doing this work in the present war. We have a grave problem, and we must analyze the circumstances with which we have to deal. Anyone who is familiar with the results that have been obtained by Kazanjian, Hayes, Davenport, Morestin, Valadier, and the other men who have been doing this work abroad can have but one opinion of what has been accomplished, but these men have now been engaged in this work for one or more years while we have not yet started.

It is or has been the custom to transport these cases back to special centers where qualified men are stationed. In the meantime the patients receive what might for want of a better term be called general treatment. We have recently been told by Crile that the most important step in the preparation for the care of our wounded is to plan to give them the proper operative treatment within the first twelve hours, and if this is done, that primary union may be obtained in 90 per cent, and that gas gangrene, etc., may by this means be eliminated. This may be too much to expect literally of mouth injuries, but I feel absolutely certain that in over 90 per cent of these cases earlier treatment would accomplish even better results than late treatment where reconstruction must overshadow conservation, and that Kazanjian, Morestin, and the others, could accomplish even better results in the individual cases with less effort and less distress to the patient, if they could have their plan of treatment started in the earlier hours after the injury, than later when the wound is complicated by infection, muscular spasm, infiltration of the tissue or scar contraction.

In the light of our past clinical observation and of what we have learned from workers abroad, it is our hope to place in every evacuation, base, and recovery hospital, men who are familiar with the problems and technique of dealing with these face and jaw injuries so that from the very first each of these patients will receive the best that surgery has to offer.

Where are we to get the large number of trained men to do this work on the scale as planned?

There are in this country at present a large number of men who have specialized in oral surgery. These are men of dental training, many of them with medical degrees, who have gone beyond the treatment of the teeth, to devote their attention to the peridental structures. These men understand most of the oral problems, the application of splints, etc., but as a rule are not accustomed to doing the major surgery that is required for many war injuries.

The surgical principles of treating oral and face injuries are the same as those applicable to wounds of any part of the body.

Wounds of the soft parts, if seen early before infection has occurred, may frequently be immediately repaired by suture. The wound is cleaned of all blood clots, hæmorrhage is controlled, and foreign bodies are removed; with the latter are included totally detached bone fragments. Above the lower border of the body of the mandible, local and general conditions permitting, immediate closure of the wound should be made, but all shreddy and pulpified tissue is removed by clean excision, no attached fragments of bone being removed. If the defect is too large for simple suture, then, local and general conditions permitting, undermining of the borders may be done with provision for drainage of these pockets, or the wound is closed by flap operation. If the parotid duct is severed, provision for drainage into the mouth is made. In the neck there are two especially notable danger zones in reference to subsequent infection: (1) The lower parts of the subfascial spaces that lead directly in to the mediastina, and (2) the immediate wound area about a ligated carotid or carotid primary branches. In the first instance the danger is that of mediastinitis, whereas in the second it is the possibility of fatal secondary hæmorrhage. The blood supply, and therefore the resistance to sepsis, is not as good in the neck as on the face. Recent wounds after proper preparation are sutured with ample provision for drainage. If the deep subfascial spaces are opened, in the deepest part of the lower end of each invaded space a small strip of gauze packing is placed. If one of the primary branches of the external carotid artery is divided, this part of the wound is packed, because sepsis here predisposes to fatal secondary hæmorrhage. A wound in the trachea or larynx may be sutured, the more superficial part being packed to furnish drainage away from the tracheal lumen. A wound of the pharynx or œsophagus is sutured and the line of union reinforced by some superimposed tissue, but the mediastinum is guarded by a light packing at the lowest and deepest part of the wound. These packs are not allowed to remain when fouled. A wound completely through the floor of the mouth, as Billroth long ago pointed out, should never be primarily sutured on account of the danger of indurating infection and secondary hæmorrhage. If the bones are involved, then the remaining portions should be splinted in their proper positions and no attached fragment removed. Every pocket, every open bone cavity, and the lower end of every fracture line should have efficient dependent drainage. If this is done early, it is surprising to note the conservation and regeneration that may result. After the bony fixation and drainage have been provided for, then the soft parts may be repaired as outlined above. The necessity for late repairs will largely be in inverse ratio to the early care that the case has received.

It is by associating the capable general surgeon with the dental oral surgeon and sending them out as units that we propose to furnish this skill in multiple. If any apology were needed for this plan it is to be found in the recent report in a lay journal by W. W. Keen of the operation performed upon the late President Cleveland, in which one maxilla was removed and replaced by a prosthesis so perfect as to defy detection. This was an example of co-operation of the surgeon and the dentist.

In order to correlate the work and to present the special war problems, short course schools have been established by the Surgeon General in several cities where these surgeons and the dental oral surgeons working together will be molded into working units.

Until their services are needed abroad, these units are co-operating with the dental surgeons at the cantonments in an attempt to eradicate peridental infections from the mouths of our soldiers. It is hoped by this to materially lessen the medical casualties on the other side.

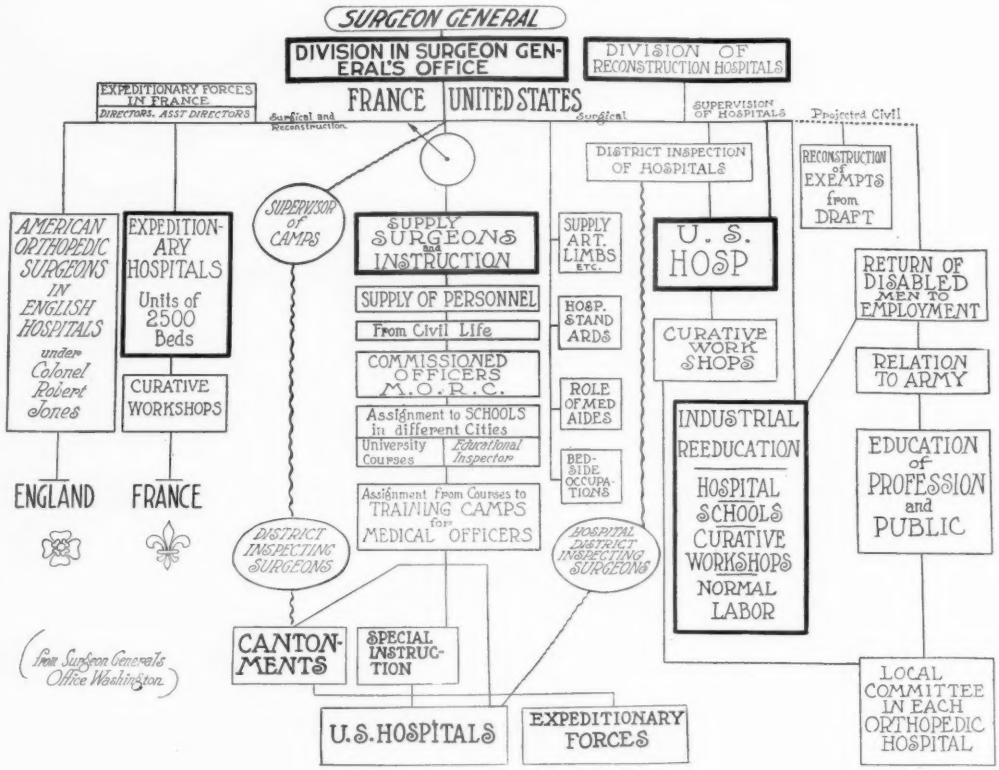
These are the aims of the Sub-Section of Plastic and Oral Surgery in the program of preparedness.

ORTHOPEDIC SURGERY

By Major E. G. BRACKETT, M.R.C., U.S.A.

IT is one of the far-sighted policies of our Government to begin in the midst of its early preparations for the destructive part of war, to make just as elaborate preparations for the repair of that human damage, which will come as a result. These preparations are being made not merely to repair those physical disabilities which will be a part of the casualties, but just as extensively for the complete restoration of the efficiency of the man, physical and industrial. This effort is based on the acknowledgment that a man, who is well and a wage earner, is taken from the community, and is placed in the service of the Army and there injured. He should, therefore, be considered as a ward of the Government until he can be returned to civil and industrial life, restored in every respect to his highest level of efficiency.

The problem has been made clear to us by the allied countries, which have been obliged to work out its solution under an emergency. We have the advantage of being able to learn from them, the methods and the size of the task. With this oppor-



tunity for preparation, we should be able to adapt their methods to our somewhat different conditions.

The problem for the orthopedic surgeon does not differ materially from that of the other departments of medicine, except in extent, and in its dealing with those conditions which so often demand a long corrective period, and which must be a part of the plan from the beginning of the treatment.

There are two principal considerations involved in the plan to bring these men, who have been disabled, back into normal civil life:

I. *The surgical.* The quick restoration is the essential element. To avoid the many disabilities which may occur by delayed treatment, the plan outlined by the Surgeon General is followed. The preparations are made in order that the special care may begin as far back in the line as possible, with the shortest line of communications and with the fewest changes before arriving at that base where the permanent part of the treatment will be given.

In this general plan, the part which orthopedic surgery has been asked to fill is shown in the diagram above. This shows the various phases of the problem, and the means by which they may be met.

In order to insure the early and continuous cooperative care of the men who are to be given special treatment, the medical forces, working both in France and in the United States, are to be guided by the same general plan.

The Division of Orthopedic Surgery was established by the Surgeon General to insure the coordination of the work in both countries. For the care of men overseas, a number of beds sufficient to meet the demand, have been planned and are under way. The hospitals will be built to contain 250 beds each and fitted with the curative workshops. About 70 surgeons are working in the orthopedic hospitals in England under Col. Sir Robert Jones, many of whom will be detailed to take up the work among the American soldiers in France when the need arises.

Special provision to supply artificial limbs in sufficient numbers is necessary.

In order to supply a sufficiently large number of men who will be capable of responding to this work, as well as to the demand in the cantonment camps and base hospitals, special training is being given to those members of the Medical Reserve Corps who

have applied for work in this division. This course is given in the form of intensive training in the universities and hospitals. This training is intended to give the necessary preliminary instruction in the principles which will be applicable to the military needs of orthopedic surgery. The training will be continued under the older orthopedic surgeons, who are in service and on duty at the various posts. Men are chosen for this training who have already had surgical experience and practice. This special training should result in eventually producing the best type of surgical specialist; viz., the surgeon who has turned his general surgical experience into special lines of work, in order that he may focus his skill, and through such concentration, produce the greater efficiency.

II. *The establishing of industrial occupational facilities* in intimate relation, both administratively and geographically, with the hospital:

Thus the curative workshops will be built as part of the hospital equipment, so that the men, while still confined to the hospitals, may at the same time be carrying on their vocational and curative work. In such an arrangement, where the vocational work overlaps the surgical, no time is lost.

The necessity of getting injured men well enough to return to their normal occupations at the earliest possible period is so well recognized by medical men and by those who have to do with industry, that it needs only to be mentioned. When once the grip on the working habit is lost, particularly through the depressing influences of protracted physical suffering, the recovery of the atrophied mental grip is rare. Under the conditions of war, this menace will present itself in its worst form.

This work of the orthopedic re-habilitation must be looked upon as having three distinct phases, yet so closely allied and interwoven that they make one problem:

1. The physical restoration.
2. The industrial re-education to fit the new physical conditions into the existing social relations, which must be resumed.
3. The re-installation in normal employment.

The man must first be reconstructed surgically so that he may be rehabilitated industrially under the most favorable physical conditions. The industrial re-habilitation is difficult enough to the pupil, and involves many pitfalls and discouragements. We must remove all avoidable obstacles that the task of re-learning may be as smooth as possible. This means the preparation for early care: it means the anticipation of those disabling conditions which as a result of injuries threaten the locomotive system, and the installation of preparation for them. It means the early installation of simple occupations, adapted to the period of convalescence, to avoid even the early subconscious habit of idleness, which, students of such cases tell us, may begin in two weeks. It means linking to the surgical treatment, the industrial work, in order that it may be a curative element in the period of recovery. It means the placing of the individual in his reclaimed condition into that position where he can best use his powers.

This work of rehabilitation in its three phases of restoration, re-education, and re-installation, is an activity which is most stimulating, for it is not directed alone toward the provision of a temporary emergency, which will end with this military crisis.

The need of this same rehabilitative work as a factor in solving our civil and industrial problem, has been evident for some time, and already attempts have been made to meet the need through the establishment of such work. Thus, this military problem will merge directly into the permanent civil one, and can then be turned over to meet the municipal demands. The establishment of this rehabilitative work under the military necessity, its development under a Federal control, with the working out of the practical details of operation, its demonstration as a working plan, with the various means by which it may be accomplished, the education of the people as a whole to its recognition and its necessity, can be brought about under this appealing crisis in a way and to a degree of completion, and at a rate that would be impossible under any other conditions. It will make it one of the lasting contributions which can come out of the disasters of this war.

Therefore, with your help, if we build wisely, we shall build permanently.